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Forthcoming Events.

NOVEMBER 14.

British Foundrymen's Association: London Branch.—"Foundry Work from a Draughtsman's Point of View," by F. W. Hubble (Luton).

NOVEMBER 18.

British Foundrymen's Association: Sheffield Branch.—"The Genesis and Development of the Foundry Cupola," by R. Buchanan, F.R.S.A.

NOVEMBER 22.

British Foundrymen's Association: Birmingham Branch.—"Cast Iron: Its Nature and Properties," by F. J. Cook.

NOTES AND COMMENTS.

The Practical Value of Metallurgical Knowledge.

There are still some who are inclined to discount the value of metallurgical knowledge in actual foundry practice, and regard it as more or less the experimenter's special requirement. But a cursory examination of some of the mistakes that are daily occurring in foundries will readily show that much improved practice might result from even a little real knowledge of metallurgical science, and from the proper comprehension of the many factors which affect the final condition of a casting. Some instances of this came before our notice recently, and may be recorded.

In one case two hydraulic pipes were required, exactly to template, to complete the jointing of a system. They were to be 9 ft. long by 9 in. bore ⅜ in. thick, with flanges 1¼ in. thick, turned and faced, and drilled for ⅞ in. bolts. At the foundry in question the actual moulding was as good as could reasonably be expected, but the staff did not profess any acquaintance with metallurgical theory, as might be gathered from what transpired.

The pattern was prepared with an allowance for shrinkage of ⅛ in. per foot, and rammed up horizontally in sand, and in due course the mould was poured. When the casting was set, but before it was cold, the mould was broken on the top, presumably to ease for contraction, then covered again and left. In the machine shop the casting was found to be too long, and when compared with the pattern had only contracted 1/40 in. per foot, and after facing to specified length the flanges were ⅞ in. thick instead of 1¼ in. thick. The pipes were forwarded to the job, and promptly condemned and returned. The pattern was shortened, and two more pipes cast under similar conditions, and accepted.

The second case occurred in the same foundry. Four castings were made in open sand from the same pattern, a box frame for moulding lamp standards, and were about 10 ft. 6 in. long. The pattern had been used before, and the castings from it had always developed a curve, allowance for which was made by ramming down the ends of the pattern ¼ in. The same was done on this occasion, but instead of the ends rising on cooling the reverse took place, and when a pair was assembled a hollow of 1 in. in each was found, making a space of 2 in. This necessitated the ends being chipped to obtain straight surfaces, which, as may be imagined, added considerably to the cost.

The questions which then, naturally enough, arose were: Why did the pipes shrink so little? Also, were they as strong and sound as they should be? In the case of the box frames, why was the curve on cooling reversed? At first sight the problems appeared perplexing. When, however, all the facts were available, the solution was at once apparent, and quite simple, and no abtruse theory was required to account for the phenomena, reference being required merely to facts well known to foundrymen. Chilled or white iron contracts more than grey or slowly-cooled iron, and iron on solidifying expands before commencing its final con-

traction. Further, if iron remains longer in contact with cupola gases than is required to rapidly melt it, extra carbon will be absorbed, to be thrown out later as graphite. In a heavy casting cooling from the bottom upwards, this graphite would rise to the surface, but under some conditions it would be retained in the metal, and finally appear as large flakes between the ferrite crystals.

In the present instance, it was ascertained that the cupola was of low efficiency, melting only three-quarters of the amount in a given time that might have been expected, and that was, in fact, guaranteed by the maker. Consequently, the metal was never at a high temperature, and was poured cool; also it remained too long in contact with the coke, and absorbed nearly the maximum of carbon possible at the cupola temperature. The latter fact was demonstrated in the deep machining of the flanges on the first pipes, when an exceptional quantity of graphite was revealed. It only remains to add that the pipes were poured from the bottom of the mould and that the feeders were of comparatively small section, and the subsequent condition of the casting will be understood. The iron which eventually formed the top of the pipes passed through the cold mould, and came to rest ready to solidify at once, was chilled on the surface and a skin formed. Since chilled iron contracts more than grey, it might be expected that the pipes would shrink the full $\frac{1}{8}$ in. per ft. allowed, and this would probably have occurred but for the operation of other factors.

When the skin solidified, it expanded and filled the mould tightly. Now, had the metal inside also frozen at once, cooling and contraction of the whole mass would have proceeded regularly, but owing to the thickness of the metal, it remained fluid for a time, though only just so. When the skin, on freezing, expanded, the interior was completely filled from the feeders, which were the next to solidify and prevent the return of any metal, keeping the skin for a short time in tension. This tension was maintained by the iron next beneath freezing and expanding in its turn, and the process was continued from surface to centre, and, lastly, there being no further supply of metal from the feeders, the surplus graphite found its way to the centre, with the result that the pipes consisted of hard, brittle skins, distorted under internal stress, surrounding a spongy interior filled with graphite.

The source of the trouble was the metal being too cool. Hot iron would have warmed the mould, and with radiation proceeding slowly and regularly, when freezing did occur, it would have been when nearly all the metal was at the same temperature, and the expansions and contractions would have taken place through the whole mass, instead of in successive layers. But the excess graphite would then have come to the top and left a dirty skin, unless the working of the cupola had been improved, so as to prevent the absorption of excess carbon. Vertical casting in the case in point also would have given a better result in this respect, and allowed any excess of carbon to rise to the feeding head. In this case shortening the pattern amounted to a confession of incompetency.

The essential difference between casting in open sand and in an enclosed mould is that in the former the surface, being exposed, is liable to cool before the rest of the casting and to chill, shrinking more than the grey interior and tending to draw the top edge into concave shape, this tendency being increased by contraction taking place above while freezing expansion is occurring below, the portion first to solidify determining the final shape of the casting. This did not occur with the frames mentioned, however, for they became convex on top with the hollow on the bottom edge. This effect followed from what was the chief fault in the case of the pipes; the metal was not hot enough. The top edge of the casting was heavier than the lower edge, and thus contained more metal. On pouring the metal at the bottom rapidly solidized, performed its freezing expansion and began to contract, while the top edge being larger, remained fluid longer, and cooling proceeding from the bottom upwards; the last part to expand was the top, and this edge on further cooling could not alter the shape assumed by the lower edge under the strains mentioned. This reversal of the usual and expected behaviour, was due to the reversal of the cooling order in the mould, and not to any metallurgical peculiarity of the iron, which, had it been hot, would have warmed the mould sufficiently to allow fairly uniform cooling, and produced a straight casting.

Power and the Development of Industry.

It is probably not realised by many to what extent power supply affects the conduct and development of most industries. One has only to refer back to the time, not many centuries ago, when wood constituted practically the sole fuel employed in this country, to realise the restrictions under which the developments of certain industries were accomplished. To-day, with a plentiful (at present) supply of coal for fuel, those restrictions are largely removed, but as the higher stages of advancement in metallurgical and engineering practice are reached, further refinement is called for; and what has served as the mainstay of past progress is, in some quarters, regarded as unsatisfactory. To take a concrete example, the employment of coke as the fuel for melting pig-iron for foundry work is, despite its relative cheapness at present compared with other sources of power, admittedly not ideal; but naturally it will continue to hold a place so long as the element of low cost effectively balances the disadvantages. There can be little doubt in the minds of most men, however, that eventually coke and similar fuels will have to be employed rather as a means of generating electric power, which appears to be distinctively nearer the ideal than any form of solid fuel. At present, however, we appear to be some distance from the time when the economical generation and distribution of electrical power will place that form of energy available for general industrial purposes in successful competition with the older fuels. The problem is one of organisation and technical knowledge, and without both of these in a more advanced stage the employment of electricity will be slow.

As an example, however, of the effect which proper organisation of electricity generation and distribution can have, we may refer to the remarks of Mr. C. Vernier in his inaugural address as Chairman of the Newcastle Local Section of the Institution of Electrical Engineers. He stated that in that portion of the North-East Coast served by the power companies the use of electricity from public supply sources had increased by over 3,200 per cent. in the last ten years, whereas in the part of the district which was not supplied by those companies, and which included many of the large towns, the increase was under 450 per cent., which was also about the average for the whole country in the same period. How much remained to be done in regard to the development of the heavy industrial power supply might be seen from the last Census of Production, which showed that in 1907 the total horse-power used in the factories and mines of this country was 10½ millions, of which 1½ millions, or only about 14.3 per cent., represented the total plant capacity of public electric-supply undertakings. A further surprising fact revealed by that Census

was that there was plant of approximately 1,000,000 h.p. in private hands for generating electricity, producing an output equal to fully 62 per cent. of the entire output of the public supply undertakings.

It will probably be contended that the great majority of applications of electricity are outside the metallurgical industries. But while this may be so, it must be remembered that for many other applications which are now quite general, a few years ago electricity was regarded as out of the question. The chief factor operating against the use of that power is the high cost of current; but this is by no means to be regarded as a permanent objection. When it is stated that some users are generating their current at less than ½d. per unit, as against 4d. per unit charged by some power-supply companies, the possibilities are at once evident. There is much to be done in the utilisation of energy which is now going to waste, and the conversion of that energy into electric power. As Mr. Vernier remarked, by the proper recovery and utilisation of the surplus gas evolved in the operations of coking, some 100,000 million cub. ft. of gas would become available, which, if used in gas engines, would yield over 500,000 h.p. Our blast furnaces produce some 10,000,000 tons of pig-iron annually, and assuming an output of 150,000 cub. ft. of gas per ton, with an average calorific value of 100 B.Th.U. per cub. ft., the disposable gas, about 40 per cent. of the whole, if utilised in gas engines, would give 685,000 h.p. Therefore from these two sources alone, even if only 80 per cent. were utilised, power to the extent of 1,000,000 h.p. could be obtained, irrespective of the use of exhaust steam from reciprocating engines.

Then, again, there are great possibilities in the correct utilisation of coal itself when employed for the generation of electric power. It is the opinion of one writer that electric power supply must inevitably centralise in the colliery districts, and that its generation will be carried on in electric power stations which will make stations of to-day seem quite small. In America the standard steam turbine unit is 20,000 kw., whilst the tendency is to go still higher. The same writer considers that an ideal electric power station would be one to give, say, 100,000 kw. in four or five steam-turbine units supplied with steam from gas-fired boilers, the gas being produced by a by-product plant using coal direct from the pit; and that for an electro-chemical or metallurgical base load, such a power station should be able to sell electric energy at less than $\frac{1}{10}$ of a penny per unit. Cheap electric power supply depends largely on the load factor, and the best load factors are given by electro-chemical and metallurgical processes. There is nothing impracticable in these suggestions, though it will admittedly be some years before such developments affect the general course of foundry work. When, however, they do, the foundryman, amongst others, will have to seriously set about putting his house in order and discarding some old ideas.

It will, of course, be understood that the cost of supplying electric power to any particular spot must be greatly affected by the distance from the point of generation; for the installation and maintenance of a distribution system is an important factor in the cost of such power. It is largely for this reason that some plants can generate their own power at such a comparatively low cost. But the adoption of higher voltages has done much of recent years to reduce the cost of distribution; and with a proper scheme of generation whereby the cost of fuel carriage, etc., would be practically eliminated, coupled with a distributing system of high efficiency, much might be done to supply electric power at more reasonable rates. Moreover, it is bound to come.

American Foundrymen's Convention.

During the week of October 10 to 17, Chicago was the chief centre of interest in the American foundry world, for in that city was being held the annual meetings of the American Foundrymen's Association, the American Institute of Metals, and the Associated Foundry Foremen. As is the custom at the annual gathering of these Associations, there was held concurrently an exhibition of foundry supplies and equipment, under the auspices of the Foundry and Machine Exhibition Company, to which nearly all the prominent foundry plant and supply firms in the country contributed, the number of exhibitors being nearly 170, and the exhibits covering every branch of the foundry's requirements. This Exhibition is regarded as an important feature of the Convention, as it enables foundry managers and foremen to become acquainted with the latest practice in foundry work and the most modern appliances in a style otherwise impossible. The Exhibition was accommodated in the International Amphitheatre, Chicago, one of the largest exhibition buildings in the United States.

As regards the Associations, the meetings were held simultaneously from Tuesday until Thursday, inclusive, October 14 to 16. The sessions of the American Foundrymen's Association and the American Institute of Metals were held simultaneously; the Convention being opened by a joint meeting on Tuesday morning, October 14.

The programme of entertainment, in addition to the various social functions and excursions, included visits to the leading foundries, steel plants and other industrial establishments in Chicago and vicinity.

American Foundrymen's Association.

The programme of this Association's sessions included the following:—

Tuesday (October 14) morning, Joint Opening Session.—Addresses of welcome and responses. Reports of officers of American Foundrymen's Association, American Institute of Metals, and Associated Foundry Foremen. Reports of Committees, etc.

Tuesday (October 14) afternoon, Joint Session.—"Apprenticeship System in the Metal Industries," by M. W. Alexander; "How to Make a Time Study," by C. E. Knoeppel.

Wednesday (October 15) morning Session.—"Grey Iron for Motor Car Castings," by H. B. Swan; "Electric Steel Castings," by F. T. Snyder; "Some Difficulties in Pouring Steel Castings," by R. A. Bull; "The Pattern Shop as Related to the Steel Foundry," by E. R. Swanson; "Some Observations on Miniature or Detachable Open-hearth Furnaces," by W. M. Carr; "The Electric Furnace for Steel Castings," by Albert Hiorth; "On the Influence of Changing the Composition of Malleable Cast Iron," by P. Rodigin (Russia); "A Study of the Annealing Process for Malleable Castings," by E. L. Leasman; "Malleable Troubles," by Dr. R. Moldenke.

Wednesday afternoon.—Excursion to Bismark Garden.

Thursday (October 16), Morning Session.—"The Need of Standard Specifications for Cast Iron," by R. S. MacPherran; "Memoranda on Automobile Cylinder Founding," by Robert Crawford; "Core Tests and Specifications," by H. M. Lane; "Testing Moulding Sands under Commercial Conditions," by Prof. E. A. Johnson; "Vital Points in Foundry Practice," by J. J. Wilson; "The Carnegie In-

stitute of Technology," by Dean C. B. Connelley; "Put Your House in Order," by Frederic A. Parkhurst, M.E.; "The Need of a Common-Sense System for the Foundry," by E. W. Riker.

Thursday (*October* 16), *Afternoon Session.*—"Iron, Where Does it All Go To?" by D. C. Wilson; "On the Relative Value of Foundry Flour, with Simple Methods of Testing," by G. S. Evans; "Memoranda on Accident Prevention," by Thos. D. West; "The Use of Powdered Coal as Fuel," by W. S. Quigley; "Memorandum on the Centrifugal Blower for the Foundry," by Dr. R. Moldenke; "Oxy-Acetylene Welding and Cutting," by W. S. Hoyt.

American Institute of Metals.

The programme of this Institute's session included the following Papers :—

Tuesday, October 14.—"Report of Official Chemist," by C. F. Woods; "Report of Bureau of Mines," by C. L. Parsons; "Report of Bureau of Standards," by G. H. Clamer; "Internal Strain in Bronze Castings," by J. E. Howard; "Work in Metals of the Bureau of Standards," by G. K. Burgess; "Nomenclature of Non-Ferrous Alloys," by G. B. Burgess; "Brass Foundry of the Future," by C. P. Karr.

Wednesday, October 15.—"Efficiency Engineering in the Foundry," by E. A. Barnes; "Scientific Management," by W. M. Corse; "Scientific Management," by F. A. Parkhurst; "How Scientific Management Works in Our Plant," by C. B. Bohn; "Core Room Economics," by O. F. Flumerfelt; "Boiling of Metals," by Dr. J. W. Richards.

Thursday, October 16.—"Producer Gas for Brass Melting," by E. F. Bulmahn; "Commercial Operation of the Hering Furnace," by G. H. Clamer; "Silver Plating and Spotting-out," by C. F. Burgess; "Fluxes for Soft Solders," by W. Arthur; "Aluminium Solders," by W. Arthur; "Approximate Melting Points of some Commercial Alloys," by A. B. Norton and H. W. Gillet.

Bearing Metals and Tests.

Mr. T. Lynch, of the Westinghouse Electric and Manufacturing Company, contributed to the proceedings of the Congress of the International Association for Testing Materials a Paper, entitled "A Study of Bearing Metals and Methods of Testing." The conclusions drawn as the result of the tests made and a large amount of service experience are thus stated by the author :—(1) The number of compositions of Babbitt metals should be as few as possible, preferably one of the tin-base and one of the lead-base, and each should be made the best of its class. (2) The constituent metals must be of superior grade, carefully tested and inspected, since the first requisite is a good raw material. (3) The alloying or smelting is of vital importance, and must be so done that the high- and low-melting-point metals may be properly alloyed far below the melting point of some of the component parts. A temperature of 500 deg. C. and less has been found to be sufficient to obtain satisfactory alloying of Babbitt metal. The melted metal should at all times be kept covered with powdered charcoal or other protection from oxidation. (4) Pouring the Babbitt too cold tends to produce a granular or coarse crystal formation, and pouring it too hot tends to produce a softening effect. The lead-base Babbitt is not nearly as "fool-proof" as the tin-base, and therefore the range of pouring temperature is more limited. However, a pouring temperature of 460 deg. C. (450 deg. to 470 deg. C.) for both lead-base and tin-base Babbitts has been found to give most excellent results. (5) Heating the shell to 100 deg. to 150 deg. C. before the Babbitt is poured into it tends to prevent blowholes and similar defects, and also prevents the lining from shrinking away from the shell. (6) Babbitted bearings must not be jarred while the metal is solidifying, since any disturbance at this temperature tends to enlargement of the crystals and corresponding brittleness. (7) The matrix of the lining metal should be just stiff enough to support the hard crystals. These hard crystals should be as numerous as possible and yet not lie on each other to cause brittleness. (8) A Brinell hardness of 23.5 for lead-base and 30 for tin-base Babbitts has been found to give most excellent results. These tests and suggestions are offered simply as a study to be furthered by those interested in applying Babbitted bearings to their several service conditions; and while no final decision can be reached as the result of these tests, they certainly do emphasise the great importance of working closely to given compositions, and of following definite processes checked by chemical tests, Brinell tests, hammer tests, careful supervision, and finally by the court of last resort, service.

British Foundrymen's Association Prize Scheme.

It was decided at a recent General Council meeting of this Association to inaugurate a prize scheme in connection with the Papers presented before the Branches. It was decided that each Branch should choose the two best Papers read before it during the Session, and forward them to the General Secretary, and that the Awards Committee should select the best for the diploma. The rules for judging of Papers are as follows :—

(1) That prizes be alloted to each Branch to be given to the member giving the best Paper, provided that the Paper is considered by the Committee to be worthy of the same.

(2) That the award take the form of a framed diploma suitably inscribed, the cost not to exceed thirty shillings. Books or instruments to the same value may be had in preference.

(3) That the Awards Committee consist of the Literary Committee of the Council of the Association, and the President of each Branch, or failing him, one of the members of the Council of the Branch, elected by that Council at their annual meeting.

(4) All classes of members are eligible with the exception of members of the General Council.

(5) All MSS. to be handed in to the Branch Secretory, who will transfer same to the General Secretary.

(6) Maximum marks :—Originality of the subject or methods used, 100; original research carried out, 200; thoroughness of acquaintance with the subject, 100; industry of the writer in collecting data, 100; literary skill, 50.

Scrap Brass in the Cupola.

When melting scrap brass in a cupola, the brass can be tapped from the cupola in the same manner as iron, into clean ladles and poured into cast-iron ingot moulds. These should be well tapered inside to permit the ingot to drop out easily. After being poured, the metal solidifies rapidly so that one mould can be used repeatedly. When the moulds become too hot they can be cooled with water. The metal also can be cast in a sand bed, but the resulting ingots are not so clean looking.

Moulding a Crank Case.

By J. G. Robinson.

The subject of this Paper is a crank case for a 250-b.h.p. four-cylinder vertical gas engine, and the writer proposes to follow it through all the stages of its production, comprising moulding, coring and casting. Fig. 1 shows a longitudinal and cross-section of the casting required, the overall dimensions of which are 12 ft. by 5 ft. 2 in. by 4 ft. 2 in. From this view it will be seen that although a pattern can be made for the outside shape of the casting, the inside has to be formed by means of a core or cores.

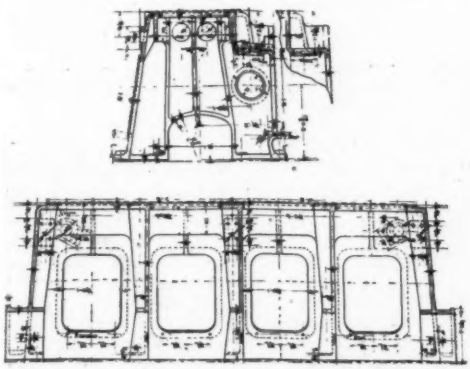


FIG. 1.—LONGITUDINAL AND CROSS SECTIONS OF CRANK CASE.

Some founders make one large complete core, but we divide them into four parts, making the joints follow the edge of the internal ribs. By having loose ribs one box can be utilised for all four cores. It will be noticed on one side of the casting there is a recess close to the bottom flange. If the pattern were made to this shape it would not leave the sand, so this recess is formed by cores. The other cores required are for the four rectangular holes in each side, and the four round holes in the top. The prints for these cores are shown on the pattern in Fig. 2. Those on the sides are attached to the facings, and made to work loose, as they will not draw out of the sand with the pattern.

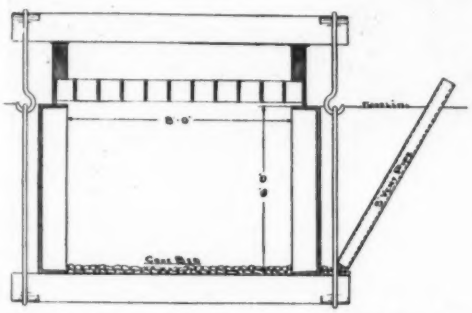


FIG. 3.—SECTION OF BED IN WHICH MOULD IS MADE.

Having decided how the pattern and core boxes shall be made, it will perhaps be advisable before proceeding with the actual moulding operations, to describe the tackle used. The use of a bottom part of a moulding box renders possible the bolting together of all the parts to resist the pressure exerted when the metal is poured into the mould. If, however, the bedding takes place in the floor, either the top part must be weighted or some other provision made to resist this pressure. The castings under consideration are moulded in a pit sunk in the floor and provision for resisting the pressure of metal is made by using three binders across the bottom. These are connected to three similar binders across the top, all the six being made of cast iron of 12 in. by 6 in. section, of sufficient length to extend over the full width of the pit.

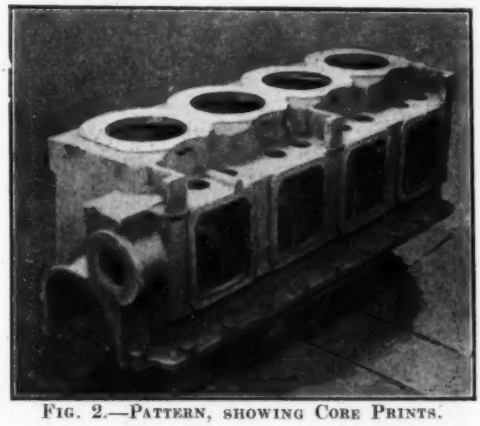


FIG. 2.—PATTERN, SHOWING CORE PRINTS.

After the bottom binders are fixed, wrought-iron links are placed under the ends and extend to the level of the foundry floor. Inside the links cast-iron stanchions which also extend to the same level are placed on the tops of the binders. The top of these stanchions forms the level of the joint. When the mould is completed, the top part takes a bearing on the stanchions.

Cast-iron girders of the same length as the box are next placed on and across these the three top binders are fixed. Other wrought-iron links with hook attachments are connected to the bottom links and threaded over the ends of the top binders, which are then lifted by the crane to pull tight on the links. This leaves a space between the long girders and the binders in which packings are placed, the whole being finally tightened up by means of wedges.

These are the permanent arrangements of the pit (Fig. 3), which is of sufficient size to accommodate

* Paper presented before the Birmingham Branch of the British Foundrymen's Association.

the largest castings we make, and can, of course, be used for smaller ones. It might here be stated that at the bottom of the pit a good coke bed is laid, which being sufficiently low down is seldom disturbed.

The pattern is now measured, and the pit dug out to suit whatever size of casting is required, the most important factor being the depth, as the bottom bed is what is first required for the placing of the pattern. Round the sides and ends sufficient clearance is allowed, but the depth from the top of the stanchions to the bottom bed must be such that when the pattern is placed on the bed, the top of it is level with the top of the stanchions.

In the first instance the depth is made about 1½ in. greater than that of the pattern, to allow for a thickness of facing sand. A pair of wood strips are fixed in the bottom (Fig. 4) sufficiently distant from each other to suit the core prints on the pattern and of the required length for same. A straight-edge is placed across the tops of the stanchions, the tween being made level throughout its entire length. We have now a perfectly level bed on which to place the pattern.

The two strips are then taken out and the spaces left rammed up very firm, as any weak place on the bottom will be found by the metal during casting operations, owing to the depth of pressure. The pattern is then fixed in position, the core prints just resting on the bed. As previously mentioned, the bottom of the pit all round the edges of this bed is 1½ in. lower than the bed face, thus leaving room for facing sand to be rammed under the bottom face of the pattern. After this has been carefully done all round, facing sand is applied up the sides of the pattern for about 2 in., the remainder being filled in with floor sand. The bottom of the pit is then well rammed all over with pegging and flat rammers, particular attention being required to make a firm job on the round corner at the bottom of the pattern, for as all moulders who have experience of similar castings well know, any straining which

FIG. 4.—PREPARING BOTTOM BED.

FIG. 5.—PATTERN IN PLACE.

distance from the underside of this to the top of the strips in the bed being made equal to the full depth of the pattern. This being repeated at both ends, an equal depth is obtained at the four points of the strips, which are rammed firm in their places. The permanent stanchions being just a rough job, may not be dead level, but they are set true to a level before being finally fastened, after the bottom strips have been arranged at the proper depth.

The sand between the two strips is dug up and shovelled out to a depth of about 1½ in., facing sand being then filled in. This is well rammed both with a pegging and flat rammer to provide a firm bottom on which to rest the core prints on the pattern. This is not a face with which the metal comes into contact, so it can safely be rammed hard. Another straight-edge is now used long enough to reach across the two strips bedded in the bottom, the sand be-

occurs is invariably on the rounded edge. When this is completed there is practically a level edge all round the bottom equal in height to the upper edge of the rounded corner.

For this casting two runners are required at each end, provision for which is now made. In order to show this more clearly the pattern has been withdrawn to obtain the photograph, Fig. 6. The in-runners are fixed level with the bottom face of the mould. The projecting facings on the end of the pattern necessitates rather long in-runners. The bottoms of these are formed by loam cakes 22 in. long and 10 in. wide. These are placed with one end about an inch under the edge of the pattern. The runner itself is formed in another core as shown. This is placed on top of the loam cake and butted against the pattern. The down runners are now placed on the loam cake, one side being against the

top core containing the in-runner. Sand is rammed round these to keep them in place, after which facing sand is applied next the pattern on the ends and floor sand filled in ready for the next ram.

The sides of the pattern now receive attention, a row of straight irons being fixed along the whole length. A clear space, however, is left in the centre of each of the core prints for the rectangular holes. This is necessary because provision has later to be made for fixing these cores in position. This is done by driving a wrought-iron stake down the back, thus forming a support to which wire can be attached. The wrought-iron stakes will be mentioned later. Facing sand is applied all round, and the next ram of about 6 in. proceeded with in the ordinary way. Then another row of straight irons is fixed all round, followed by another ram, which brings us up to the recessed part of the pattern, where the last row of straight irons is fixed all round. Another ram brings us up to the bottom edge of the core prints for rectangular holes, where flat irons are affixed to keep the print firm. These are 1½ in. wide, ¼ in. thick and extend 3 in. beyond each end of the print. This is necessary to support the weight of these cores when being fixed.

Ramming then continues in the ordinary way, except that on the ends long irons are placed between the pattern and the down runners and a few straight irons between the core prints on the sides.

When the ramming reaches the top of the side prints an additional number of straight irons are fixed about 1 in. apart over the top of the eight prints, forming a firm support for the sand round.

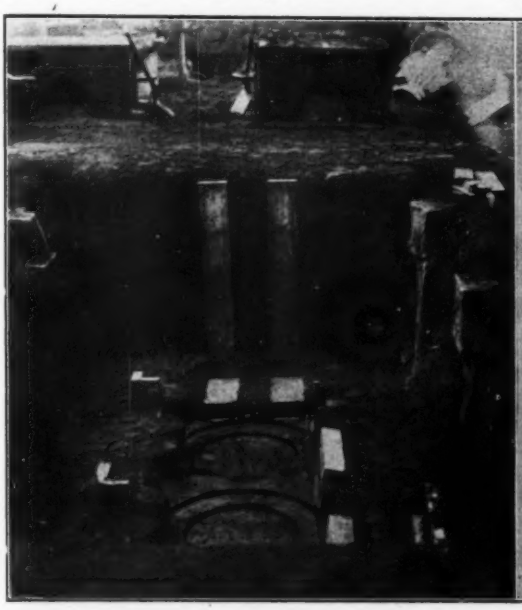


FIG. 6.—SHOWING RUNNERS FIXED.

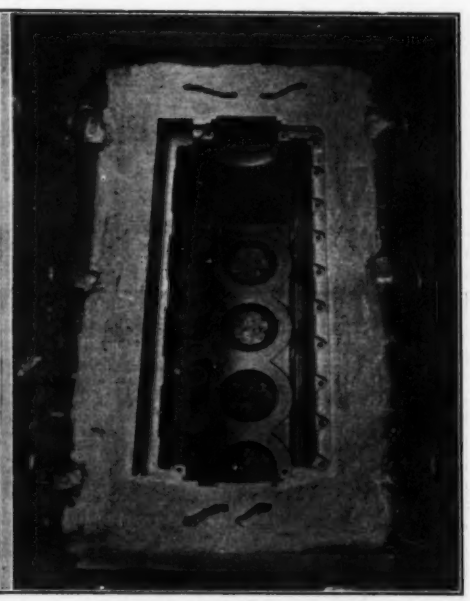


FIG. 7.—MOULD READY FOR CORES.

The wrought-iron stakes before mentioned are then driven down, after which ramming continues up to the joint in the ordinary way. The down runners are then withdrawn and the holes covered with plates, an operation rendered essential owing to the employment of a broken runner.

The joint being perfectly flat, after the application of parting sand, the top is lowered on. Measurements having been made for depth in commencing the job, and the pattern fixed accordingly, the top part rests on the stanchions from the binders previously described. Before any sand is filled in, the down runners and also risers from five places along

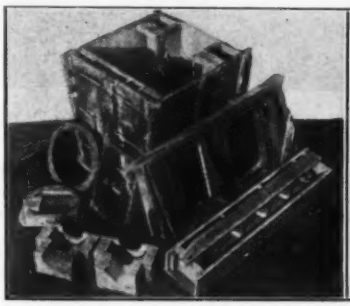


FIG. 8.—CORE BOXES.

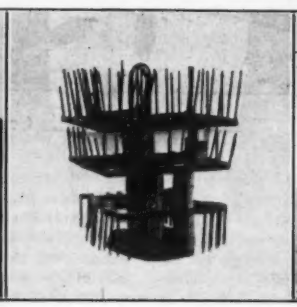


FIG. 9.—GRID FOR MAIN CORE.

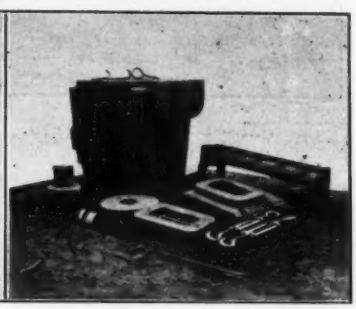


FIG. 10.—SELECTION OF THE CORES MADE.

each side are fixed. These risers are at the points where the ends and cross-ribs join the side. The top is now rammed up to use green. Special facing sand is prepared, consisting of three parts of new and two parts of old sand well milled and riddled on to a thickness of about 1 in. The bars in the box being fairly close, no gaggers are necessary, so it is simply rammed up with floor sand, after which guide stakes are driven in at the four corners. As there is no bottom box with pins, this is necessary for replacing the top part later on.

The runner and riser pegs are then withdrawn and the top lifted off. The plates over the down runners are removed and the runner pegs dropped in place again. The joint is swept off and watered round the pattern, and the main body of the pattern withdrawn, leaving the side facings and prints, etc., which were described as being loose, still in the mould.

Provision is now made for the finishing of the mould. As it is necessary to have something for the moulder to stand on in the bottom, round wrought-iron plates rather smaller in diameter than the bottom core prints are placed where these have been.

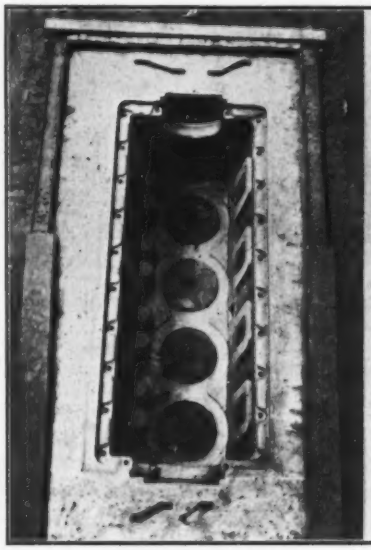
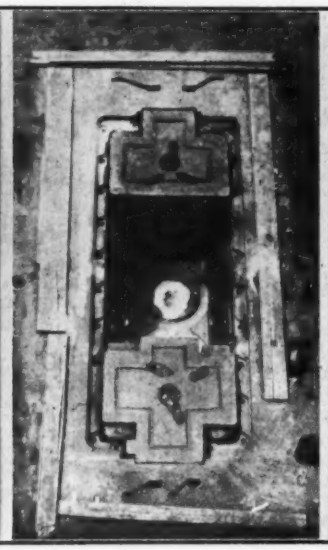


FIG. 11.—CORING COMMENCED.



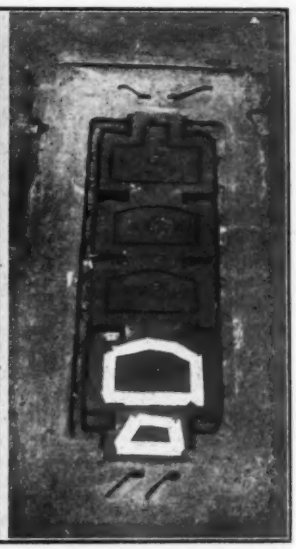


FIG. 12.—SOME OF THE CORES IN FIG. 13.—ALL CORES IN PLACE.

These allow sufficient standing room and prevent the bottom from being damaged. Commencing at the joint and working downwards the task of finishing is now proceeded with. This work is done principally with a cork rubber, and in this matter I wish to express very strong opinions. I consider that more than 50 per cent. of the wasters made in a foundry are due to too much sleeking with a trowel, and that were a trowel used less and a rubber more the percentage of wasters and the trouble to the foreman would be considerably reduced.

The edges all round are well sprigged and also the bottom of the mould face sprigged before the loose facings are withdrawn. Holes are cut out of the centres of the side prints, back to the stakes previously mentioned, to which the cores are wired.

After all finishing is completed, the mould is wet blacked, sleeked up with the tools and washed over with thin gum water (Fig. 7). It is now ready for drying, which is done by means of two portable stoves. At the point where the hot blast enters the mould it is possible to obtain a red heat, and unless the face of the mould were in some way protected it would naturally be burnt. To afford this protection sheet iron (usually old corrugated sheet iron) is laid along the bottom and up the sides. The top of the mould is then covered with cast-iron plates kept for this purpose, on which the stoves are placed. The drying is done during the night, as we always have a night man at work and electric power from the Corporation mains.

At this stage we can turn our attention to the core making. The first core to be taken into consideration is the main body core. In the particular casting we are dealing with the box is made to suit each of the four divisions (Fig. 8). In some cases in the smaller engines the core box is made so that two cores can be rammed up at the same time. This has the advantage of helping to keep the box square, but in this case handling is not so easy. It will be noticed that the box in question is securely bolted together, a practice which has often opened up an argument between the core-maker and the pattern-maker as to whether it is better to have everything bolted up, and consequently a fixture, or to have the box made so that when the ramming of the core is finished the bolts can be taken out and the box sides and end allowed to fall apart, leaving the core standing on the bottom plate. By doing this a certain amount of time spent in finishing can be saved, but we have found that when the cores are dried and ready for fixing in the mould they have been out of true, either through the box being rammed out of shape or not having been properly bolted together in the first place. For this reason these boxes are made a fixture, and have to suffer rapping in consequence, when the core is being lifted out.

The box itself, as previously mentioned, is made so that with certan alterations to the inside ribs, etc., it will suit all four divisions. As all cores vary from each other, a different set of core irons is required for each. In the first place, a strong bottom

grate is made, having three staples cast in sufficiently long to reach to the top of the core for lifting purposes. The total depth of the box is 4 ft. 2 in., and in addition to the bottom grate three others are used for strengthening the core, these being fixed in the box as shown. Each grate is kept at least 2 in. clear of the sides of the box to allow for contraction in the casting. The core-maker measures his box and makes his irons to suit, leaving spaces to clear the ribs, etc., inside. He is also particularly careful to see that no bars foul the lifting staples from the bottom grate.

In some cases where a man is not familiar with the work it is necessary to have a template made by the pattern-maker for some of these grates, but at our own shop the man who usually makes them simply measures the inside of his box, marks out a square on his sand bed, takes the brackets, etc., out of the box, fixes them in position inside the square and stamps in his bars to clear.

Having prepared the grates we are now ready to proceed with the making of the core. In the first place about 1 in. thickness of sand is rammed along the bottom of the box, the bottom grate being bedded on to this. A row of gaggers is then fixed round

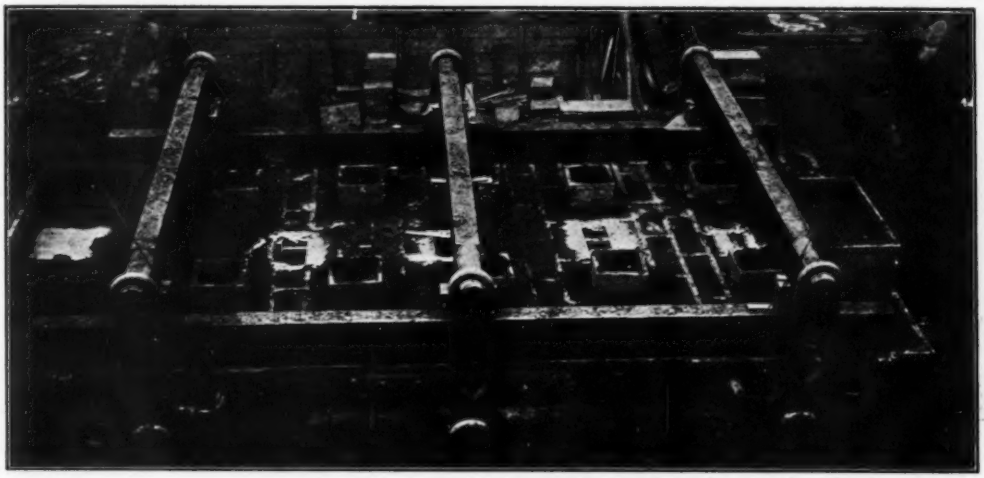


FIG. 14.—FINISHED MOULD READY FOR POURING.

to carry the sand in the 2-in. clearance mentioned. Sand is then filled in and rammed up to the level of the top of the grate. At this point packings to carry the weight of the upper core grates are fixed. These usually consist of three bricks on end, as shown in Fig. 9. A row of straight irons is next placed close on to the grate all round. These strengthen the bottom of the core and prevent the same from splitting for any distance up when placed on the plate for drying. Sand is now faced up the sides of the box to the level of the brackets in the bottom, where there is a set-off in the core forming pockets of sand to be carried. After this sand is packed in position the whole is well vented to the sides and bottom of the box with a $\frac{1}{4}$ in. vent wire.

The centre is now filled in with ashes, leaving about 4 in. of sand on the outside. All is now rammed up to the level of the projection, and the next grate is placed in position. It will be noticed that the prods are fixed downwards, and are for the purpose of carrying the sand in the pockets. A few gaggers are fixed to carry the sand where the prods miss, after which packings are again fixed, sand faced up the sides of the box and vented, and ashes filled in as below. This is now rammed up to the height where the third grate is necessary. Immediately under this a row of straight irons is placed. These prevent the sand bursting away during drying. We have found that during drying the expansion of the grate has burst the sides of the core, and there being nothing to hold the sand underneath it has broken off in big patches. This the straight irons prevent. The next grate is now fixed and packings and ramming proceeded with exactly as below, except that additional rows of straight irons are used to carry the sand, which really overhangs on account of the taper up the sides of the box. All irons are kept $\frac{1}{2}$ in. clear in case it should be found necessary to rub the core.

When the core is rammed up to the top of the box and strickled off, a groove is cut all round, about 4 in. from the edge. When the cores are fixed in position this is filled with soft loam to prevent the metal getting into the vents. It is now necessary to lift the core out of the box. This is done by hanging screw hooks on to the three staples which are carried through from the bottom grate. By this means it is possible to get a level lift with the crane. The box is well rapped, the weight being taken by the crane. Directly the core moves it is practically clear on account of the taper, and as it is so well gaggered and ironed very little sand drops off during the operation.

Whilst it is hung up in the crane the bottom is made good and finished. The core is then lowered on to a plate ready for conveyance into the drying stove. Loose parts are removed, and the remainder finished and wet blacked. The bottom of the core is blacked after drying.

The remainder of the cores are quite simple. The round ones for the bottom are made in oil-sand, and form a strong support for the main core to rest upon. The cores for the inspection holes at one side are plain and of an even thickness, but on the other side they are made tapering to suit the shape of the pattern. These are also made in oil-sand, but it will be noticed there is an open space in the centre showing the grates used for carrying same. These are utilised later for wiring these cores into position.

The following morning the stoves and plates are removed, the wrought-iron plates taken out and the

work of coring begun. This usually occupies two days. All the small cores are fixed the first day, after which there is a certain amount of patching and blacking to be done, which requires drying (Fig. 10). For this purpose the drying apparatus is rigged up again and blown for about four hours during the following night. This dries all the patches and prevents moisture striking back in the bottom of the mould.

The first cores to be fixed are the ones on the sides for the inspection holes. A twisted wire is looped round the wrought-iron stake which is driven down the back of the prints, and the core placed in the print. The wire is then threaded through the grate left bare for that purpose and then twisted up tight. This operation is repeated on all the eight cores. These having been fixed, a straight-edge is tried along all the faces to find out whether they project the correct distance from the face of the mould, so as to leave the space required for the thickness of metal. Any variation can be rubbed off and a true face provided for the main body cores to fit against.

The two cores under the flange and the smaller cores are now fixed, and the spaces in the centre of the side inspection cores filled with core sand, dressed off and blacked. The bottom of the mould is cleaned

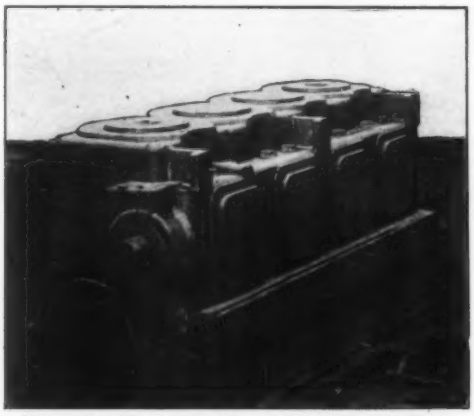


FIG. 15.—FINISHED CASTING OF CRANK CASE.

cut and the plates in the round prints removed. The round cores are then placed in position. As the edges of the prints for these cores sometimes get disturbed, the centres are carefully measured to ensure their being correct. The sand round them is made good and all places that have been patched are blacked. The round plates are then placed on the tops of the cores, as an extra protection for the next night's drying. This is necessary on account of their being made in oil-sand. The same applies to the side cores, which are protected as on the first occasion of drying. As previously remarked, the mould is warmed up again during the night, and on the following day the only cores to be fixed are the main body cores. The mould is now carefully cleaned out, as when these cores are fixed it should be ready for closing.

The end cores are fixed first, Fig. 11, as mentioned during the core-making. These have three staples for lifting purposes. Screw hooks are attached to these staples, by which means a perfect adjustment for levelling the core is obtained. This having been done, whiting is placed on the round core in the bottom, on which the body core rests, and pieces of clay on the places which project under the bottom edge of the body core to assure correct spaces for metal. The core is now lowered into position, the side cores being a guide to work to, whilst on the end a thickness piece of wood is used.

When down in positon the spaces left for metal all round are tried with thickness pieces to ensure their being correct; after this the core is lifted out and all thicknesses of clay measured. The whiting mentioned shows when the core has rested evenly on the bottom bearing. The side cores are inspected to find if anything has crushed, and when all is satisfactory the core is again lowered into position, pieces of waste, etc., being placed in the spaces on the top to prevent anything dropping down. The other end core and middle cores are fixed in like manner, except that extra precaution must be taken over the last core, which has to fit against the other cores on all four sides.

During the time the cores are being fixed, one man is finishing the top. When the top is lifted off the pattern there is a guide showing where the outline of the pattern comes, from which measurements can be made to mark off all the places where the metal comes in contact with the top part. These places are all face sprigged, as are any other soft places, *e.g.*, under the box bars, and made good. A good coating of plumbago is well rubbed in. The position where the vents in each body core will come against the top part is ascertained, and holes are cut through the sand to correspond with them.

The top is now turned over ready for lowering on to the mould. Previous to this all the grooves in the top of the body cores are filled with soft loam (Fig. 13), over which paper is placed to prevent cohesion with the top part. The top is lowered into position and then lifted off. All the cores are inspected to ensure the top has touched everywhere it should, and that no crushing has occurred. All being satisfactory, the waste, etc., packed in the spaces during coring is removed, and the top again placed on. Care is taken to ensure that the box edges rest on the six stanchions mentioned when preparing the pit. If necessary, iron wedges are driven in these places.

The runners pegs are now fixed, and the pouring basin made. Clays are placed over the risers and bushes or risers boxes placed over them. The binders for bolting down are now fixed. The two side ones are first laid on; then the others across and the links fixed over the ends. The centre binder is now lifted by the crane, packings are placed under each end on to the side binder and wedged firm, the end binders then being treated in the same manner. Everything is now ready for casting (Fig. 14), after which operation we sincerely hope the casting will turn out good. This is left in the sand all next day and taken out the day following. Fig. 15 shows the finished casting.

Model Engineering and Scientific Exhibition.

The fourth Exhibition of models, tools, and scientific apparatus, organised by the proprietors of "The Model Engineer," was held at the Royal Horticultural Hall, Westminster, S.W., from October 10 to 18. There was a splendid entry of engineering models from all parts of the Kingdom for the various competitions, and some very interesting exhibits were shown in the loan section. Special rooms were devoted to wireless telegraphy in operation, and to aeroplane models of all kinds, while a completely equipped workshop was manned by members of the London Society of Model and Experimental Engineers, who gave demonstrations of model making and workshop operations. The principal model yachting and power boat clubs of London showed their latest craft, and this section included the team of English boats which recently won the International Championship at Paris.

Making a Pipe to Template.

By F. Andrew.

The making of pipes to template is a method often resorted to in fixing the last of a series, or in replacing a defective pipe, of an irregular shape or otherwise. In replacing an existing pipe, the old one is often used as a template, from which the new one is set out. Where the piping is new, a wood template is made for the closing pipe, which may take the form of an elbow, straight length, or almost any shape, with perhaps branches on the sides in addition. A complicated example is taken in the following description.

Four pipes are shown in Fig. 1, each running in a different direction, and it is assumed that these are to be connected by means of an elbow pipe from *a* to *b*, and two short branches from *c* and *d*, at right angles to the long arm of the elbow. The patternmaker proceeds to make the template, by fastening to each

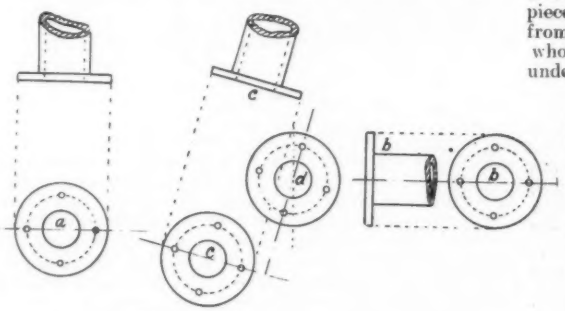


Fig. 1.

flange a wooden flange of the same size, with bolt holes to correspond. By means of stout strips, which are made to follow the shape of pipe required, the four wooden flanges are firmly connected, so as to retain their positions relative to each other, and the bolts removed.

On removal, the template requires further treatment before it is ready for the moulder, as the wooden flanges occupy the same position as will those of the finished pipe casting, and allowance will therefore

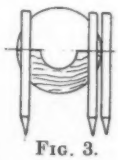


Fig. 3.

Fig. 4.

Fig. 5.

have to be made for contraction and machining. For this purpose, thickness strips are added to each flange.

First, the short end of the elbow is measured, and contraction and facing-up allowance from flange to centre line of pipe added to flange *a*. Next, similar allowance is added to flange *b*, for the length from centre line of short end to face of flange *b*. The allowance added to flanges *c* and *d* must be in two directions, one for contraction from centre line of elbow to the centre of branch flange, the other for contraction and facing for the distance from face of flange to centre line of pipe.

Fig. 2 shows the template with the additions made as above, and attention is drawn specially to the branches and the allowance for contraction in length of the body of pipe. In this view the template is shown as bedded in the sand, the main (elbow) pipe being levelled. Provision is made under the bottom branch for bringing away the vent by means of a coke bed underneath and extending to one side, an outlet being provided before closing the mould, by piercing the joint a few times with a thick vent wire.

By means of square wooden stakes with good faces, the moulder makes preparation for ensuring the correct placing of the flange patterns, two stakes to either flange, and an additional one at one side of each flange, as shown in Fig. 2. The bottom branch flange requires different treatment, and after being made firm underneath with facing sand, is staked round the piece added for contraction, which is a little further from the bend than the flange it is fastened to. The whole of the stakes being in position, and the sand under each flange made firm, the template is with-

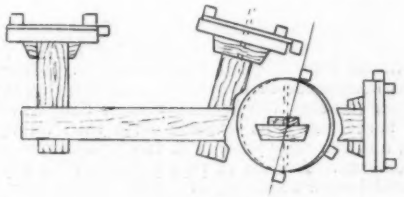


Fig. 2.

drawn and the half of a flange pattern set to the stakes in each case and levelled, the stakes being marked along the joint of the flange, which will also be level with the mould joint. Fig. 3 shows a half flange levelled, and illustrate how, later, the level or joint mark is transferred to the face of the template flanges, to serve as a guide to the patternmaker in

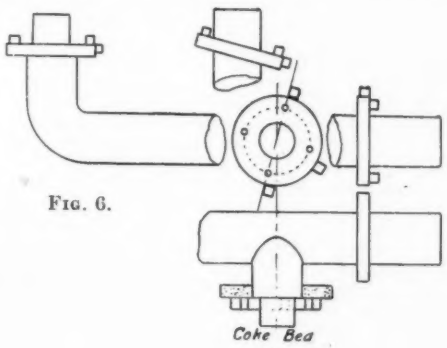


Fig. 6.

Fig. 7.

preparing small templates for setting the bolt-hole cores. A half-flange is placed up to the stakes in the bottom branch, and the joint line made to come in line with the faces of two stakes, as an aid to transferring the line to the template flange.

The pattern-maker makes his small templates as Fig. 4, and sets the flat side of print of same to the joint line on the template flanges, made by the moulder, the holes in the core template being opposite to those that served to bolt the template flanges in position, as in Fig. 5. Whereas the print on the core templates for the two main flanges, and that of the side branch, are on the face side of the flange, that on the bottom branch must be fixed to the back, so that when in use, the print being uppermost, it can be more easily set to the two stakes which mark the joint line.

Reverting to the mould, the flanges are replaced, levelled and made firm, and the spaces between fitted with pieces of pipe pattern to suit the shape desired, and projecting beyond the flanges somewhat. These

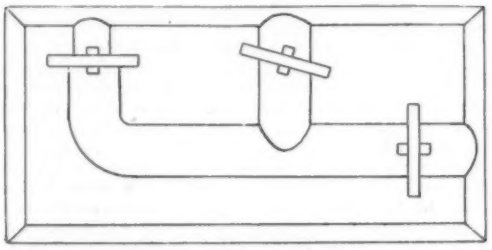


Fig. 8.

are also rammed round and facing sand applied where necessary, the whole being rammed up to the joint level, without removing the wooden stakes. After the joint has been made in the rough, a hole is dug round the guides locating the bottom branch flange, which is then bared. A joint is made level with its upper surface, and the body pattern of the pipe immediately above removed. A piece of pipe pattern with a print at one end is now required, of such a length that the upper end will come level with the bottom of the body pattern which has been removed. This short piece of pattern is put in position, the print passing through the hole in the centre of the flange, and resting on a firm sand bottom. A cake core of sufficient size to well cover the flange, and with a hole in the centre to suit the body of the branch, is next fitted and staked.

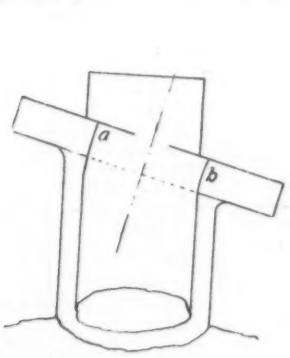


Fig. 10.

The cake core, branch pattern and flange are then removed, and the flange mould finished, blacked and the cores set by the template, working the flat side of the half-round print to the joint mark obtained by putting a short straight-edge across the two stakes which were put in for that purpose. These stakes can now be withdrawn and their places made good, and to make sure that the small cores are not washed out of position by the metal, they are fixed with sprigs and the cake core again put in position. Fig. 6 shows a plan of the mould joint in the rough, also the flange mould for the bottom branch, with cores in position, and the joint line used for determining their position from the template. Fig. 7 shows in elevation a section through the bottom branch, with flange cores, cake core, branch body and pattern for body of pipe, each in position, also showing the position of the coke bed required for carrying away the vent from the branch core.

The whole can now be covered and rammed level with the main joint, which can be completed. The stakes round the flanges can also be removed, and small brackets, one at each side of either flange, used

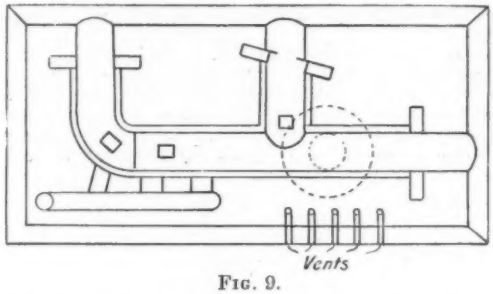


Fig. 9.

to keep the flanges in their correct position. Fig. 8 shows the completed joint and the brackets referred to, in position. As it is unlikely that a proper pipe box of the correct shape to fit the pipe would be obtainable, an ordinary flat box is used and this requires a double joint, one level with the centre of pipe, the other level with top of the flanges, the rise, which in this case will be about 6 in., being made by a sloping joint which connects the two.

The box is next placed in position resting on the upper joint, the down-runner peg placed suitably, lifting screws put in the flanges to bring them away when the top is lifted, and provision made for loosening. The bottom joint is covered with a thin layer of sand all round the pattern, to serve as a bed for the gaggers used for lifting the body of sand which comes

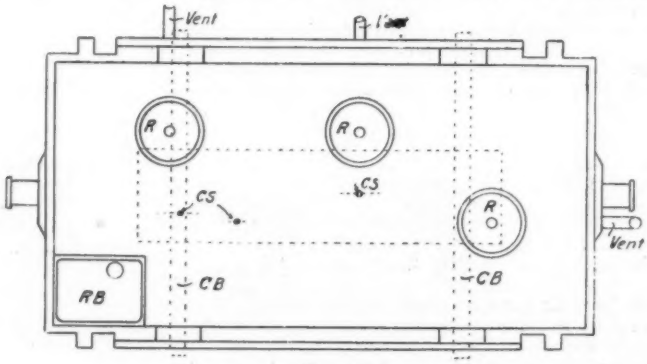


Fig. 11.

below the bottom edge of the box. After gaggering the box is filled in and rammed firmly by stages up to the top, care being taken that the runner does not come too near the pattern. The box is next staked to ensure its return to same position after removal, care being taken to keep well clear of the bottom branch, to avoid disturbance of the finished flange.

The box is then vented by a thin wire immediately over the top of the pipe pattern, the runner peg withdrawn, and the pattern loosened by means of a pointed bar and a hammer, through the holes prepared. These holes are afterwards filled in, the lifting screws in the flanges secured, and the top removed and placed on a pair of trestles, resting on a pair of trunnions, which serve for turning the box over for finishing purposes. The patterns are withdrawn, and chaplets or supports body core will rest are made firm, and the whole of the mould is finished and blacked. Care is required to prevent sand getting down the bottom branch body, such sand being difficult to remove.

The chaplets are then set to the correct height to give the thickness of metal required, the flange cores put in, set by template and made firm. The bottom branch core is fitted in its print and set to correct height, the vent being closed at the upper end, and carried away from the bottom to the coke bed previously prepared for this purpose. Fig. 9 shows all cores in position, with the plates on which the chaplet stems will rest, one each on the branch at side, the elbow, and the straight length. The runners are also shown, and the method of bringing the vent away from the coke bed, this being accomplished by means of several holes made with a stout vent wire from the joint down to the bed, the holes at the joint being connected by means of channels with the outside of the mould.

Reference to Fig. 9 will show that the side branch core requires to be of special shape on account of the flange beng at an angle to the branch body. The method of obtaining the shape will be seen on referring to Fig. 10, and consists of rubbing the branch core at *a* to obtain the correct width of flange face at that side. The other side at *b* requires the width of flange face reducing, and this can be done by adding to the core on that side, or, as is often done, left to be chipped off. All the cores being now fitted and made central in the different flanges, the top box, which has also been finished, is replaced in position in the stakes. The chaplet plates previously referred to, and shown in position on their respective cores, have been removed, and the stems, which project through the top box, are pressed down and given a few turns to mark a position for setting these plates when the top is again removed.

This "trying off," as it is termed, is necessary to enable the moulder to see whether any crushing has occurred in the prints behind the flanges, and also to try the thickness shown by sprigs which have been left projecting at different parts of the mould, these sprigs being afterwards removed. Any dust or dirt which may have got into the mould is blown out, and the chaplet plates placed over the marks in the core caused by turning round the stems, after which the top box is again finally replaced.

Fig. 11 shows the top after replacing, showing the runner box or pouring basin R B and the risers R. All the joints at the core prints are luted with wet floor sand, small pipes being placed in position to keep a clear passage for the vent and prevent metal entering accidentally. Bearers are placed on the box edge to support cross-bars C B, which serve to support the weight necessary to resist the upward pressure of the metal on both mould and cores. The position of the weight is indicated by a dotted line across both cross-bars, and after being placed in position the chaplet stems C S must be prevented from lifting by means of packing and wedges placed between them and the weight or cross-bar immediately above.

After casting and cooling, the pipe is dressed and the cores removed, the casting being taken to the machine shop to be machined on the flange faces to the size of the original wooden template, from which have been removed all thickness pieces provided for contraction and facing-up allowances.

Cast-Iron Specifications and Inspection.

In a brief Paper presented by R. S. McPherran before the Chicago Convention of the American Foundrymen's Association, the writer put forth a plea for more uniformity in making specifications for and in the inspection of iron castings. There were, he said, specifications written calling for test bars 1¼ in. by 12 in. round, 1 in. by 2 in. by 24 in., 1 in. by 1 in. by 12 in., 1 in. by 1 in. by 4 ft. 6 in., and 1 in. by 1 in. by 4 ft. 8 in., etc. Sometimes the bars were to be corrected to some definite sized bar, and sometimes to some unfamiliar quality factor. Some specifications called for transverse bars only, some for tensile only, and some for both. The minimum breaking load for 1 in. by 2 in. by 24 in. transverse bars varied from 1,700 to 2,500 lbs., and the tensile strength per square inch from 18,500 to 25,000 lbs. One specification called for a tensile strength of 18,500 lbs., with an "allowable variation of 5 per cent. either way." These different requirements on the part of engineers only served to confuse the manufacturer, and in the writer's opinion much should be left to the judgment and experience of the manufacturer.

Continuing, the author said:—In a shop where a certain kind of castings are a part of the regular output, the shop practice in making them is based on actual experience, both in manufacture and in service. A purchaser calling for changes from his shop practice should do so only after careful consideration of the situation and for some definite reason. It is too often the case that a specification is copied from some handbook and inserted bodily in a contract without regard to the class of material it is to cover.

Specifications should be enforced with some consideration and evidence of good judgment. Reasonable latitude should be given the inspector in the interpretation of the specification clauses. Too severe a construction of a poorly written specification often causes unnecessary loss to the manufacturer. In one case in the writer's experience the specification for suction piping called for a breaking load of 2,200 lbs. on a transverse bar 1 in. by 2 in. by 24 in. between supports. The same specification called for a tensile strength of 20,000 lbs. per square inch on bars cast to represent the steam cylinders. During the manufacture of this engine a set of transverse bars broke below 2,200 lbs., and caused the rejection of a suction pipe. The tensile bars from the same iron broke over 20,000 lbs. per square inch, which would have passed a high-pressure steam cylinder. We have here the anomaly of a material satisfactory for steam cylinders, but causing the rejection of a suction pipe.

The above is not to be taken as an argument against specifications or inspection, but only as an illustration of how both may be misapplied.

In conclusion, the writer urged the members of the Association to bring into their specifications, whenever possible, the bar which forms the basis of the specifications for cast iron and iron castings adopted by the Foundrymen's Association some time ago, working co-jointly with the American Society for Testing Materials. This bar, it will be remembered, is 1¼ in. round, cast on end in dry sand, and tested transversely on supports 12 in. apart.

Before the Sheffield Society of Engineers and Metallurgists last month Professor W. E. Dalby, M.Inst.C.E., F.R.S., Dean of the City and Guilds College, London, lectured on "Load Extension Diagrams, and their Relation to the Structure of Metals."

Economical Foundry Cost-Keeping Methods.*

By E. W. Riker.

No business is made a success by the cost system alone, though business success is rarely secured to its full extent without the aid of a cost system. It is the chief instrument used to obtain a high degree of efficiency through intelligent, energetic and enthusiastic management, made practical by good organisation, permanent policies, and business integrity.

Accurate cost control of a foundry by economical methods is possible beyond the question of a doubt. A foundry cost system can be devised to fit the foundry for which it is designed, that will absorb and account for every disbursement for material and labour, whether this it a direct or productive item or an indirect or non-productive charge. Furthermore, these disbursements may be separated or classified to divisions or departments of the foundry to show current costs of departments for efficiency in foundry management, and also separated and charged to classes of castings or to individual orders to show complete cost of product by classes or by specific orders. All of this can be tabulated and presented weekly instead of monthly, as is done in some foundries.

The usual divisions of an iron foundry recognised as productive departments are: A—cupola; B—core room; C—moulding; D—cleaning and chipping.

The non-productive or indirect expenses, known as foundry expenses, overhead charges, or burden, include: Superintendent and foremen, foundry clerks, dispatching, yard men, general labourers, crane men, machinists, carpenters and blacksmiths, freight and cartage, pattern repairs and renewals, tool repairs and renewals, bad castings, defective castings.

These expenses are taken care of through the medium of standing order numbers to which they are charged and tabulated for distribution to the productive departments and classes of castings as part of the costs, and further to inform the superintendent or foreman in charge, currently, of variations in this class of disbursements, to enable prompt action when any specific item or items show unusual increases.

The power, heat, light, water, and protection expenses are treated in a manner similar to the other foundry expense disbursements and are distributed proportionately to the productive departments and classes.

The fixed charges, such as fire insurance, indemnity insurance, depreciation and interest, are absorbed into cost of product, but are shown on the weekly report separately, for the reason that these items, being fixed, cannot be increased or decreased by act of the foundry superintendent or foreman and, therefore, should not be included with other items of foundry expenses which can be increased or decreased by the superintendent or foreman, according to the degree of efficiency he shows in the management of the foundry affairs.

Foundry improvements or permanent investments, such as real estate, buildings, machine tools, general tools, patterns, power transmission, piping, electrical equipment, etc., are handled by the usual accounting methods applied to this class of property accounts, but the charges thereto are not absorbed in current cost of product, only their upkeep and depreciation.

Starting with the raw material, a cupola report is prepared showing grades of pig-iron melted, with quantity and value of each, and also quantity and value of machinery and foundry scrap to show total melt; from this is deducted the returns and bad castings, which gives the net cost of metal melted. To this is added the cost of fuel and supplies, such as coke, gannister, fire clay, brick, limestones, etc., together with the labour engaged upon the cupola work and the power consumed to give net cost of melt, which is reduced to a rate per pound of metal melted. From this melt and upon the cupola report the pounds of castings produced are shown. The cupola report also shows:—(1) Per cent. of good castings to gross melt; (2) per cent. of bad to total castings; (3) per cent. of returns to gross melt; (4) the melting loss; (5) the ratio of this loss to melt.

The report is complete and includes every item of cost of cupola operation reduced to a net cost per pound of metal melted from the cupola spout to the ladle ready to pour, for subsequent use in ascertaining cost of castings per pound by classes and in total, or cost of castings by jobs or pieces. The report also is decidedly helpful to the foundry superintendent or foreman in measuring the efficiency of this important foundry department. Similar reports are prepared for the core room, the moulding, cleaning, and chipping departments, to show cost of operation of these divisions, both for department efficiency and to include in the final summary of cost of castings.

The overhead expenses are tabulated in one report to show the disbursements in detail covering this class of cost. This report also shows cost of power, heat, light, etc., and the amounts that are apportioned weekly to cover the fixed charges. Thus all money expended for material, labour, and foundry supplies, whether for direct or indirect use, is properly accounted for. Finally, all these reports are summarised on a cost-of-casting sheet to show total cost of operation by departments and total cost of castings by classes, with notations of period or average costs to date for departments and classes. These several reports form the weekly cost statement with every item of cost absorbed and capable of proof with the books of account.

Additional reports in the nature of statistics may be prepared from the weekly cost reports, arranged to show results comparatively by weeks as a further guide to the superintendent in his effort to promote efficiency. A statement of comparative results arranges facts developed in the cupola department relating to good castings, bad castings, returns, total from melt, melting loss, total melt, average melt per day, defective castings, cost of metal, ratio of foundry expense to productive labour, average castings per day, both good and bad, and per moulder, and other useful data to indicate to the foundry superintendent how these regular features of the foundry are running along and what variations develop. An analysis of the product and of foundry expenses may also be arranged comparatively to inform the superintendent of variations in these items.

These statistical statements are not actually a part of the weekly cost report, but are found helpful to the foundry management in watching the trend of affairs.

In connection with the cost system and auxiliary to it, is a system of stock control which can be operated in a simple manner to properly regulate purchases of

* Paper presented before the Philadelphia Foundrymen's Association.

material and foundry supplies and to properly govern their use. A stores and stock system not only provides a current inventory, but effectively prevents careless and indifferent buying, overstocking and waste, and furnishes a means of inspection of this class of property that is desirable and helpful in the effort to economise in foundry material and supplies.

One of the strongest and most effective features of the foundry cost system, outlined in this Paper, is the weekly report scheme, for the reason that reports compiled so frequently give the superintendent or foreman in charge of the foundry the opportunity to observe irregular developments in cost of operation. For this reason alone the weekly reports are much more valuable to the foundry management than are those which are prepared only once a month.

In preparing the weekly report, the foundry cost clerk is assisted by suitable forms of recording and reporting data from the several departments which he needs for his report. This data comes to him daily on analysis sheets, thus assembling the figures needed for his weekly report each day to further enable him to compile his report at the end of the week promptly and without serious effort.

Two points in connection with the installation of a new cost system, whether in a foundry or other industrial plant, must be considered and clearly understood, namely, it takes time and perseverance. Various elements must be reckoned with and various obstacles must be overcome, but above all, to make the cost system a complete success it must have the substantial support of the chief executive of the business against all obstacles and objections.

A great deal depends upon the cost system; its elements must be thoroughly understood and it must absorb all items of cost, both direct and indirect. It is hazardous to the business to use cost figures that do not represent the total expenditures for labour, material, and expense, and which cannot be proved. It is not a difficult matter to ascertain accurately the amounts expended for direct labour and material; this is quite simple, but just how to ascertain the overhead charges and apportion them equitably and correctly to be sure that all overhead expense is absorbed, requires careful study and a knowledge of the subject obtained from years of actual practical experience.

As previously stated, the elements of a cost system must be thoroughly understood and correctly applied. These elements are:—

(1) *Material.*—That material which becomes part of the finished product.

(2) *Productive Labour.*—That labour which can be determined by a specific amount or rate and can be directly charged into cost of product.

(3) *Factory Expense.*—The large number of charges which are necessary to maintain productive labour in the operation of manufacture and which include all items of indirect labour and all repairs, power, heat, light, water, etc.

(4) *Administrative Expense.*—Salaries of executives, office clerks, office expenses, etc.

(5) *Fixed Charges.*—Taxes, fire insurance, indemnity insurance, depreciation, and interest, though the latter is not always regarded a fixed charge and often is omitted as such.

(6) *Selling Expense.*—Represents all disbursements for disposing of the product, including branches, agencies, salesmen, etc.

These six elements of cost cover all money expended except for improvements which add to the investment value, such as new buildings, new machinery, tools, and other equipment. Costs properly compiled must be classified and tabulated in accordance with the above elements.

In conclusion, let us remember the real function of a cost system is not merely to record the cost of operations, but to submit data that can be used intelligently to reduce costs; then it performs its duty and becomes the most valuable agent known to promote foundry and factory efficiency. The logical conclusion, the common sense of the condition, is that every foundry and every industrial plant needs a reliable cost system to present in an orderly manner, regularly, the facts relating to the business completely, to tell the story week by week of the actual current business conditions with exact costs of operations by divisions and departments.

National Gas Exhibition.

An exhibition which was held last month in connection with the National Gas Congress at the International Exhibition Halls, Shepherd's Bush, London, was a striking tribute to the progress which gas has made of recent years in industrial operations. The exhibition was held under the auspices and control of a committee representing the Institution of Gas Engineers, the Society of British Gas Industries, the British Commercial Gas Association, and the leading gas companies and Corporation gas committees of the United Kingdom, to commemorate the jubilee of the Institution of Gas Engineers and the centenary of public gas supply. It comprised a large variety of plant and appliances, in connection with the generation and utilisation of gas, and afforded an excellent opportunity of studying the industrial applications of that fuel. A large variety of plant and appliances was on view. Amongst that of particular interest to the foundry was a small hardening shop shown in operation by Messrs. Sanderson Brothers & Newbould, Limited, of Sheffield, and equipped with an oven and an oil tempering furnace, and also with apparatus for breaking the steel to show the fractures after it has been subjected to the different heat treatments. This exhibit well illustrated the care and accuracy required for the heat treatment of tool steels. A considerable variety of furnaces and muffles suitable for metallurgical work were also on view. Those by the Richmond Gas Stove and Meter Company, Limited, Warrington, included a natural-draft twin oven for hardening (low-pressure gas), a low-pressure gas and high-pressure air oven for annealing, hardening, etc., and a low-pressure gas salt bath for hardening steel. Messrs. John Wright & Company, of Birmingham, had on view a cyanide hardening furnace for engraver's rollers, plates, etc., a high-pressure gas crucible melting furnace, suitable for aluminium, gun-metal, etc., a high-pressure gas 300-lb. tilting crucible furnace for alloys up to copper, and other furnaces. Messrs. Fletcher, Russell & Company, Limited, Warrington, installed a gas-fired enamelling and annealing shop, in which were to be seen in operation a high-speed steel furnace for hardening cutters, dies, tools, etc., two muffle furnaces for tempering, hardening, case-hardening, annealing, etc., and a gas-heated lead bath. Another exhibit by this firm was a low-pressure gas oil bath for tempering steel, while also shown was one of their low-pressure gas and high-pressure air double crucible furnaces for all metals, including steel. A working exhibit of considerable interest illustrated the application of gas-firing in the casting of aluminium. Mr. R. W. Coan, Goswell Road, London, E.C., had installed a small foundry, in which the processes of moulding, melting the metal and castings were being carried on. A tilting crucible furnace by Messrs. John Wright & Company, and a small fixed crucible furnace, by the same makers, were included in the equipment of this model foundry.

Notes on the History of Founding.

In the course of his inaugural Presidential address before the Scottish Branch of the British Foundrymen's Association, PROFESSOR A. CAMPION said :—

The art of melting and casting metals is considered by antiquaries to have been practised before the days of written history. Whether that is correct or not, it is certain that bronze castings were produced 2,000 B.C. by the ancient Egyptians by the "lost wax" process, using loam moulds. In early Jewish history we read that Goliath of Gath went into battle with a brass helmet on his head and a target of brass between his shoulders. In the book of Joshua reference is made to the vessels of brass and iron captured at the fall of Jericho and the prophet Isaiah says "Who hath formed a god, or molten a graven image." Hiram of Tyre, who cast the bronze pillars for the Temple of Solomon, and who is described as "cunning to work all works in brass," had his foundry in the plains of Jordan where the ground was clayey. The father of Hiram was also a Tyrian brassfounder.

The great bronze pillars of the Temple of Solomon are described as being 27 ft. long and 5 ft. 9 in. diameter, and reference is made to the great molten sea 15 ft. from brim to brim and an handbreadth thick. We read also of the ten bases each having four wheels underneath, as follows : "and the work of the wheels was like the work of a chariot wheel, their axle-trees, and their naves and their felloes and their spokes were all molten." It is doubtful whether or not patterns were used in the production of the pillars, but it is quite clear that patterns were used for the bases, as we read in the 7th chapter of the first book of Kings, and "after this manner he made the ten bases; all of them had one casting, one measure, and one size."

These quotations are sufficient to show the antiquity of both pattern-making and founding, as in the time of the building of the Temple of Solomon the brass-founding business had evidently been in existence for a considerable time, and had reached a high state of development. It would have been interesting to have had recorded the manner in which these large quantities of metal were melted and cast, but in all probability they were melted in clay pots and from a large number of these the metal was poured into the mould. This, of course, necessitated the employment of a very large number of workmen, but labour was cheaper and more abundant in those times than it is now.

It is interesting to note that a similar method is used to-day in the great works of Krupp at Essen where exceedingly large ingots are made of crucible steel. A small army of men is employed and crucible after crucible of metal is poured into the mould. Krupps have cast ingots which require about 200 crucibles of metal to be teemed.

The brass to which reference is made in the quotations given was not the alloy which we now know by that name, but was a copper-tin alloy such as we know at the present time as bronze or gunmetal. The alloys of copper and zinc which constitute the brasses of the present day were not known until many centuries after the time of the Temple. It may be of interest to some of you to know that Theophilus, an old German writer and skilled worker in metals, who lived in the second half of the eleventh century, gives as a suitable composition for casting bells copper containing one-fifth of its weight of tin. This is the composition specified by the British Admiralty to-day.

Although iron and steel were known from the very earliest times, cast iron was not known until a comparatively late date. The first records of cast iron indicate that it was in Sussex about 1345-1350 that it was produced, although one writer states that it was known in 1266. It appears highly probable that cast iron had often been made accidentally, when working easily-reducible ores with a larger excess of carbon, or having a keener draught than usual, before its usefulness was realised. Once the possibilities of cast iron were appreciated, efforts were directed to its production in larger quantities and at a more rapid rate. This led to the introduction of the blast furnace, the first stage in the development of ironfounding. Epoch-making discoveries and inventions soon followed.

Professor Turner has placed the date of the introduction of the manufacture of iron castings in Britain as at least as early as 1490. A large cast-iron gun was cast in London in 1516, and in the yard of the Tower of London can be seen one or two large cannon which were sent over to Ireland in the reign of Henry VIII. and brought back to the Tower; the date of their manufacture is about 1520. The first time that the use of cast iron in England is prominently noted was in 1543 when Ralph Hogge, of Bucksteed, in Sussex, made a cast-iron cannon. It appears most probable that this cannon was a direct casting. We have evidence that the casting of iron was in use in France to a considerable extent before this date, as Ralph Hogge was assisted in the work by Peter Baude, whom he had brought over from France to teach him up-to-date practice in iron-founding. Baude started a business of his own for the casting of cannon, for we are told that he had a "covenanted servant" who exceeded his master "in his art of casting ordnance, making them cleaner and to better perfection." A son of this "covenanted servant," Thomas Johnston, is mentioned as being a "special workman and he cast for the Earl of Cumberland in 1595 42 great pieces of ordnance, each weighing 6,000 pounds."

By the time Elizabeth came to the throne the English founders appear to have taken the lead in skill and methods of casting cannon, as they appear to have exported considerable numbers to the Continent. The fuel used for smelting and melting of iron at this period was entirely charcoal, and the increased consumption due to the rapid extension of the use of iron led to devastation of the forests of England. An Act was passed by James I. forbidding the cutting of timber except in the forests of Sussex for the manufacture of charcoal for use in ironworks. At the time the Act was passed the total production of iron in Britain was 180,000 tons, but it rapidly dwindled to 17,300 tons in 1740, owing to the scarcity of fuel and the consequent shutting down of the furnaces. This shortage of charcoal led the ironmasters to look round for a substitute, and coal being abundant it was naturally put to trial. In 1612 Simon Sturtevant published a work, the title of which was "On Metallica, or the Treatise of Metallica, briefly comprehending the doctrine of diverse new inventions, but especially how to melt, and worke all kinds of mettle oares, irons and steeles with sea coales, pit coale and brush fewell." Sturtevant, however, had a rival, for there was another work entitled "A Treatise of Metallica, but not that which was published by Mr. Simon Sturtevant upon his patent, which is now by order cancelled and made voyd, whereupon Privilege by Patent is

granted to John Rovenzon, Esquire, for the making of iron and other materials, 1613."

Dud Dudley, in 1619, gave a great impetus to the iron trade when he obtained a patent from King James to make iron by a new method. His patent was declared to be related to "the mistere and arte of melting iron oare, and of making the same into cast iron workes or bars, with sea coales, or pit coales, in furnace with bellowes." The story of Dud Dudley has been so often told, that it must be familiar to you all, and I will not dwell upon his futile attempts to rebuild the iron trade of Britain by the use of small coal which was thrown aside as waste at the collieries. It is a source of much gratification to all students of metallurgical history that the Staffordshire Iron and Steel Institute have recently erected a memorial to Dudley.

Dud Dudley was not only an ironmaster but also a founder, for in his "Metallum Martis" he spoke of this country being able to "supply His Sacred Majesties' other territories with iron and iron wares and steel also, by iron and steel made with pit-coale, sea-coale, and peat; and thereby be helpful unto themselves and England and all plantations of His Majesties, on this side and beyond the line." He also states: "I also made all sorts of cast-iron wares, as brewing cysterns, pots, morters, and better and cheaper than any yet were made in these nations, with charcoles." Dudley recognised and was acquainted with three classes of pig-iron, for he says: "Give me leave to mention that there be three sorts of cast iron, (1) the first sort is grey iron, (2) the second sort is motley iron, of which one part of the sowes, or piggs, is gray, the other part is white intermixt, (3) The third sort is called white iron; this is almost as white as bell-mettle, but in the furnace is least fined and the most terrestrial of the three; the motley iron is somewhat more fined, but the gray iron is most fined and more sufficient to make bar ironwork and tough iron to make ordnance, or any cast vessels."

It was about this time that the manufacture of cast iron was successfully conducted in Scotland. In 1607 the first of the great Scottish ironmasters, Sir George Hay, who first proposed the substitution of pit coal for charcoal in the smelting of iron, began to produce iron in the neighbourhood of Gairloch. Under the control and guidance of Sir George Hay, great advances were made in the knowledge and practice of ironmaking. He put into use appliances superior to any previously used, and produced results more certain and more satisfactory than had been the custom and in a more economical manner. Not only was pig-iron made in these works, but also various forms of castings, including cannon. Many works were erected in various parts of Scotland, some of which had only a short life, whilst others, such as these at Bonawe, existed for about 150 years.

The Carron Works were established in 1759, and gave the name to the guns known in history as Carronades. The Clyde Ironworks, started in 1788, are famed in the history, not alone of the Scottish iron industry, but of the iron industry of the world, as a scene of the struggles and successes of Neilson of hot-blast fame, and of the early training of David Mushet, the discoverer of black-band ironstone, which proved of such value to the Scottish iron industry.

Blowing engines are supposed to have been first used at the Carron Ironworks, which were founded by Dr. John Roebuck, who encouraged and supported financially James Watt in perfecting his steam engine, for which he was granted a patent in 1769. I should like to mention in this respect another name, one which is very often omitted from historical reviews—John Wilkinson. The whole credit is usually awarded to Watt for the production of the steam blowing engine, but it was not altogether successful until John Wilkinson discovered how to cast the cylinders and bore them. Wilkinson was a strong believer in cast iron and iron castings. He built the first iron boat, which was the forerunner of all subsequent iron and steel vessels. He also erected in Bilston a cast-iron chapel, which contained a cast-iron pulpit. When he died in 1814 he was by his own instructions buried in a cast-iron coffin and a cast-iron monument was erected over his grave.

From this stage the foundry trade advanced by leaps and bounds, improvement after improvement being made in the manipulation and casting of iron when once the possibilities of the metal were appreciated. The foundry cupola originated and was developed from the same source as the blast furnace—the "Stuckofen" or high bloomery in which wrought iron was made. By allowing the bottom to wear deeper, thus forming a well below the tuyere, and using more fuel and charging the furnace to a higher level, cast iron was produced. Instead of tapping the slag, as was done in making wrought iron, it was allowed to remain and the blast was thus prevented from getting to the iron and removing the carbon by oxidation. When used in this manner it was known as a *blauofen* furnace. Percy says, "when blast furnaces are built slightly of brick only and hooped or cased with iron they are called cupola furnaces." The foundry cupola differs from a blast furnace only in minor details and is only used for the melting of iron.

It was not until the year 1706 that ordinary iron castings were made regularly in Britain, and even then only by Dutch workmen who had been imported to make brass. The Dutch had been famous as bell founders for hundreds of years before this date. Abraham Darby, the manager of a Bristol brass foundry, in the year 1709, first successfully cast an iron pot from metal melted in a crucible in a charcoal furnace. It was more than a hundred years afterwards before anyone else managed to cast pots, so well did Darby and his assistant guard the secret. The name of Abraham Darby is renowned in the history of cast iron from the fact that he was the first to successfully make coke and use it instead of charcoal. Dud Dudley attempted to do so in 1618, but it was not until 1733 that Darby accomplished it. It is indeed difficult to describe the benefits conferred upon the iron trade by Darby's invention. The productive capacity of the blast furnaces increased and the cost of pig-iron decreased, which paved the way for a much more extensive use of cast-iron articles, not only in this country, but throughout the world, and foundries increased both in numbers and in productive capacity.

I have said that the foundry industry dates back to ancient times and has a magnificent record, and I think that the historical review which I have tried to present to you—incomplete as it is—will be sufficient to prove my statement.

Continuing, Professor Campion urged the members of the Branch to forward to the Secretary at any time, for discussion at the meetings, any problems which arose in the course of their work. He also suggested that useful work could be done by collecting and condensing all possible information on one portion of a subject of science or practice and presenting it with one's own observations and experiences. Anyone who would undertake such work would find that at whatever stage he might arrive he would acquire not only useful knowledge but increased mental powers to record and take advantage not only of his own experience but also that of others. The speaker concluded as follows:—

This, I think, is the most important lesson that we learn from a study of the past history of the industry, when we think of what was accomplished in these early days, by men who, starting from very small beginnings, and by the exhibition of dogged perseverance and courage, were enabled to overcome enormous difficulties and to build up the great and important foundry industry. We learn that the men who succeeded were those who devoted themselves earnestly and wholeheartedly to whatever subject they undertook, and put their whole being and energy into their lifework. I think, too, that we learn from past history that all the great discoveries and epoch-making inventions have been the result of properly directed and systematic effort; and that mis-directed and spasmodic attempts have ended in failure. There are many matters of importance to the industry which require systematic investigation or standardisation and which can perhaps be better treated by a combination of workers. This represents another direction in which this Association can promote the welfare of the industry, and I am very glad to be able to announce that in this the Scottish Branch has taken the lead.

Analytic Control of Foundry Materials.

By H. S. Kipling.

Whilst most large foundries utilise the services of the chemist for the analysis of the pig-irons and scrap they purchase, in order to secure uniformity in the castings produced, a few suggestions as to the other raw materials may be useful. In the first place, the coke should be more carefully sampled than is frequently the case. The writer was employed for some considerable time on a coke plant and was there met by repeated complaints as to high sulphur in coke supplied to certain customers. These complaints almost invariably proved to be due to erroneous methods of sampling. The outer and top ends of a piece of coke contain more sulphur than the central portion, and care should be taken to secure equal portions of these parts. Frequently the sampling is left to an unskilled helper, who simply breaks off enough projecting corners to satisfy his conscience. The resulting mass (it can hardly be called a sample) may contain much more sulphur than the average, or it may contain less and so delight the heart of the foundryman with an unusually pure coke—according to the chemist's report. The percentage of ash does not fluctuate to such an extent as the sulphur.

The following figures are from a single piece of coke, and they clearly indicate the necessity for careful and intelligent sampling:—

	Sulphur.	Ash.
Outer end	1.30	11.20
Centre	0.90	10.90
Inner end	1.40	11.20

This was rather a poor coke. Generally the sulphur in centre will be under 0.60 per cent. A reasonable specification for coke is as follows:—Sulphur, under 0.75 per cent. if possible, maximum 0.90 per cent.; ash, under 8.0 per cent. if possible, maximum, 12.0 per cent. Moisture will vary according to the weather during transit, but in normal circumstances should be below 0.5 per cent. Volatile matter should not exceed 1.0 per cent. If above this it indicates incomplete coking.

In many foundries, otherwise controlled by analysis, the limestone is quite neglected. This is a serious error, as the cost of the analysis is quickly recovered by the better working of the furnace when the stone is regularly tested. A limestone is only useful for the lime it contains in excess of that necessary to flux itself. Some limestones contain so much silica that they are not able to unite with more than one-third of the silica that a pure stone is capable of fluxing. It is therefore desirable that the silica should not exceed 5.0 per cent. Magnesia should not be more than 2.0 per cent., as it tends to produce a less fusible slag. Moisture, as in case of coke, will vary according to the weather, but normally should be well under 1 per cent. The main constituent—carbonate of lime—should exceed 90 per cent. in a reasonably pure stone, and may even reach 98 per cent. under favourable circumstances in selected pieces.

Pure ganister is a silica rock of about 98 per cent. purity, but the ganister usually sold for cupola repairs contains from 10 per cent. to 40 per cent. of fireclay, sometimes naturally, but possibly occasionally added in grinding the pure rock. This clay-ganister is usually supplied as a wet pulp containing up to 30 per cent. of water. Water being very much cheaper than ganister or fireclay, it is desirable to insist on comparative dryness of the material as delivered; and as fireclay is usually supplied in lumps not exceeding 10 per cent. of moisture, there might prove some economy to large consumers in buying high-grade ganister nearly dry and incorporating a sufficient quantity of fire-clay to render the mixture properly plastic. Supposing an eight-ton truck of ganister to be delivered with 25 per cent. of moisture; this means that 2 tons of water are purchased at the price of ganister. Any moisture in excess of that necessary to render the ganister workable is objectionable, because it all has to be evaporated before the repair is able to stand the melting heat. This means an unnecessary expense for drying-fires in addition to the original direct loss.

Fireclays vary greatly in their composition, and no definite specification can be given, though each locality can generally prepare its own standard. In general terms, the oxide of iron should not exceed 2.0 per cent., and the alkalies should be as low as possible, certainly never above 1 per cent., as the alkaline silicates are very fusible. Lime and magnesia should each be under 0.5 per cent., as they, too, form readily fusible silicates. The ideal clay would contain merely silicates of alumina and be practically infusible.

In preparing a specification for moulding sand, local conditions are a controlling factor, but an excellent sand is represented by the following:—Silica, not under 84 per cent.; alumina, not over 10 per cent.; lime, not over 1.25 per cent.; loss on ignition, not to exceed 3 per cent.

Numerous other materials are well worth a little inquiry, and it will frequently be found that the cost of an occasional analysis is repaid fully by the reduced foundry costs and the improved results. It should be remembered that analytic control does not mean analysing all materials, recording the results, and never attempting to secure the best composition for each material. This simply leads the practical foundryman to ignore the laboratory entirely. The aim of an efficient foundry chemist should be to assist the foundryman by directing him to the best materials available, and by systematically checking deliveries, avoiding subsequent troubles due to the use of impure or unsuitable materials.

Some Difficulties in Pouring Steel Castings.*

By R. A. Bull.

Beginning first with the ladle as a unit and the necessity for keeping it suspended from the trolley, it is a most unsafe practice to use chains for the ladle crane. Wire rope has superseded the chain on the drums of most of the modern pouring trolleys, but not on all. The reason for the use of the rope is obvious. Many a poorly-welded link shows no surface defect, while a wire rope gives warning of excessive wear and weakness by the parting of the outside strands.

The ladle bail should not only be forged of the best possible material, and designed with a high safety factor, but it should be jointed so as to relieve undue strains caused by sudden or unexpected movements of the crane bridge or trolley. A stiff sling hooked over the ladle trunnion, rigidly attached to the cross arm, is not conducive to the flexibility which is sometimes very desirable and which undoubtedly prolongs the safe life of the bail. The cross-arm should be provided with a shield to protect it somewhat from the heat underneath, and there should be an air space between shield and cross-arm. It is a good plan yearly to anneal the entire bail as well as the cranehook, to prevent crystallisation.

In making up the stopper-rod, great care should be taken in the use of keys for securing the stopper-head. It is false economy to use a key more than once. A crystallised key may cause a heavy loss, and the cost of a new one is negligible. The joints between the sleeves of the stopper-rod, as well as those between the bricks of the ladle lining itself, should be carefully looked after. Sleeves, stopper-head and nozzle should be selected with great care, to see that none are cracked or patched, and that the contour of the nozzle enables the stopper-head to have a perfect seat.

Having made up the rod, of course the clay joints should be well dried, like the clay lining of the ladle bricks; and in drying the ladle itself many believe an upright position to be preferable. Undoubtedly the brick lining is thus less susceptible to displacement. Perfect lining would sometimes prevent those red spots which suddenly appear on the ladle plates, which are immediately followed by the melting of the latter and a very awkward breaking out of the metal. The nozzle must be carefully set and well rammed in, and the lower portion should extend below the nozzle-plate sufficiently to enable the metal to clear the plate nicely and not become "gummed" at the outlet.

The setting of the stopper-rod calls for nice adjustment under somewhat unpleasant conditions. This can best be done under the direction of the melter, so there can be no division of responsibility. In tapping the heat, the additions should be of moderate size to enable reasonably quick melting and thorough distribution. Large lumps of ferro-manganese, gravitating to the nozzle, may stick to the lip of the latter in a half melted condition, and cause a very bad shut-off. The melter should personally look after the size of the lumps constituting the additions, and the introduction of these into the ladle, which should be regulated by the nature of the tap.

Given a perfect heat and a perfect ladle, there should of course be a clean shut-off. But this is by no means always the case. The ladle-man or steel-pourer may inadvertently open up too strongly on his first flask. Then if this initial mould is moderately small so as to fill quickly, the man whose hand operates the lever may have hot work cut out for him for a period. The steel pouring over the lip of the nozzle without any check from adjacent position of the stopper-head may seem determined to flow regardless of the movement of the lever. This is due to chilled steel adhering to the nozzle, preventing a perfect seat, and caused by a tempestuous flow of hot metal in excessive quantity over a comparatively cold nozzle. A restricted flow, giving time for such a "skull" to melt away if it forms, is highly desirable on the first mould. Sometimes the stopper-head may stick to the nozzle at the start and excessive pressure must be exerted on the lever, with the result that the stream may open in greater volume than intended, through the sudden release.

Occasionally through careless manipulation of the lever, a very small amount of steel may trickle from the nozzle, which in itself may be of no consequence. This must be very closely guarded against by pinching the stopper-head tightly at all times against the nozzle. An apparently insignificant dribble is very likely to cut the nozzle and produce a nasty leak. Once the nozzle begins to cut away, the teeming of the balance of the metal should be expedited with all possible dispatch by pouring the nearest and largest moulds, for almost invariably the stream will soon become so large in area that the pouring cups will not accommodate it.

Sometimes the stopper-head or the nozzle, or both, will wear away considerably during the pour, consequently increasing the height of the lever, and preventing the ladle-man from handling it with skill. This may itself cause the steel to trickle, with the bad possibilities before mentioned. An adjustable lever to meet such contingencies is far better than a hastily moved temporary platform on which to stand or a vertical addition to the end of the lever by means of a moulder's shovel.

A prolific source of leaks is cold metal, which encourages the formation of skulls around the top of the nozzle. This cause is, of course, one easily determined, and may give very serious trouble during the early pouring. The impact of the stopper-head on the nozzle, with both in a highly heated state, will make them wear down. But if they are of good material and perfectly sound, such wear should be uniform.

I have seen leaks which experienced foundrymen have insisted were caused by the slag freezing on the top of the metal and binding the upper part of the stopper-rod. Suddenly the lever would refuse to budge, without anything being jammed on the outside of the ladle, and finally come to the desired position, shutting off the stream after considerable metal had been lost. Obviously something had interfered with the operation of some part of the stopper-rod, but I believe slag to be too fragile to resist the force applied to the lever. What produced the trouble could only be surmised.

I have not by any means enumerated all of the troubles experienced in pouring steel. Many of us have seen stopper-rods burn in two, stopper-heads burn off, and stoppers stick so tightly to nozzles that "prickers" had to be resorted to to open them. It may be mentioned in passing that wooden prickers are to be preferred, as they will not fuse to the

* Abstract of Paper presented before the Chicago Convention of the American Foundrymen's Association.

semi-plastic metal sometimes present in the nozzle orifice. An ordinary gate-stick is always available and will generally force an opening.

I have not mentioned the skill requisite in pouring a perfect heat from a perfect ladle, to guarantee the best possible results in the castings. This is a very important matter, and if not given the needed attention may throw the blame for mis-run and cracked castings on the shoulders of the melter unjustly. A knowledge of the design of the mould itself, the manner in which it is gated, the approximate weight of the casting, have a direct bearing upon the proper control of the stream. Insufficient feeding of heavy sections is not only productive of shrinkage cavities, but also, according to my observation, of shrinkage cracks, when the cavities may not be in evidence. A large number of risers of moderate size enables better feeding than does a small number of very heavy sink-heads. But however these may be designed or placed, the ladleman should hold his ladle over the mould till the risers are solidified past all hope of further feeding.

The Nomenclature of Non-Ferrous Alloys *

By Dr. G. K. Burgess.

We are witnessing an unprecedented activity in the development of the non-ferrous industries, accompanied by the search, often rewarded with brilliant success, of new combinations of metals suitable for special uses. It is only very recently, however, comparatively speaking, that the equilibrium diagrams of our most common alloys such as the simple brasses and bronzes have been established, and most, if not practically all, of the three component systems, to say nothing of the more complex ones, are still to be determined.

The art of preparing, mixing and applying them to industry in many cases has preceded by centuries the science of the constitution of the commoner non-ferrous alloys, and some of them possess names that date from times immemorial, and which no one would think of endeavouring to change—nor is this necessary. The question arises, however, whether it is not worth while, in view of the rapid development of special alloys to which are assigned a bewildering chaos of meaningless names, to endeavour to make provision for a more orderly naming of the non-ferrous alloys.

Imagine what would be the status of the nomenclature of organic chemistry to-day if there had not been developed at an early date a rational system of naming in terms of the constituents based in part on the existing names of the more common organic compounds; and I think we should all agree that the complexity of organic chemistry is at least as great as that of the non-ferrous alloys.

In the realm of ferrous alloys and their naming, although there is some confusion, it is not nearly so bad as with the non-ferrous alloys. Some rational-minded person, or persons, started saying ferro-silicon, ferro-manganese, etc., and the force of a good example soon established the habit of this simple nomenclature which is being rationally extended by the more precise numerical defining of terms such as 40 ferro-silicon, 60 ferro-silicon, etc., to indicate the percentage of silicon or other element in the ferrous alloy. Such a numerical method has been tried in a few instances also for some of the non-ferrous alloys, for instance to indicate the nickel content in German silvers, but this practice is by no means generally in vogue in either realm.

We may cite another example—this time to be avoided—from ferrous nomenclature, namely, the microscopic constituents, which, following the barbarous practice of the mineralogists, have been named after distinguished metallographists and metallurgists. These names were becoming of embarrassing number and beginning to create confusion as to their meaning and distinction, when the International Society of Testing Materials, at its Copenhagen meeting, endeavoured to eliminate this confusion by reducing the number of terms used and defining them exactly. Fortunately, this phase of needless confusion and antiquated method of nomenclature of microscopic constituents has not yet arisen in the case of any of the non-ferrous alloys, and there is no reason why the mistake of such bad practice should be made a second time, since there are adequate names in the ordinary language of physical chemistry to provide for naming rationally all such constituents.

Personal and "coined" names have been used, however, quite extensively in naming particular non-ferrous alloys or classes of alloys having very distinctive properties. The extent to which this practice should be encouraged in the future is a debatable question, but such monstrosities as "manganese bronze"—to mention but one flagrant case—do not reflect credit on any technical body of men accepting them. It is necessary, or, at least, highly desirable, if an effort is to be made to rationalise the naming of non-ferrous alloys that there be co-operation on the part of several classes of persons, ranging on the one hand from the practical foundryman or manufacturer, to the scientific man, as represented by the physical chemist and metallographist, on the other hand. A common system of naming or identification and classification becomes imperative where several manufacturers are in competition; and it is furthermore evident that in drawing up or meeting specifications, a common language is equally desirable. Clear-cut definitions of alloys will serve oftentimes as a protection to the seller, and will aid the intelligent buyer. It is also evident that in framing a system of nomenclature, it would be advantageous to consider the desirability of fixing practical tolerances at least for some of the more common alloys and perhaps the principles on which such tolerances—or variations in the product from an accepted definition—can be worked out without too great difficulty. It is here that a knowledge of the equilibrium diagrams will be of the greatest importance, since for some alloys the division line between two adjacent phases having very different properties is very sharp, while for others there is a gradual transition in properties, with change in composition. It is evident that specifications for the composition of the latter type may be less rigid than for the former in the region of a dividing line between two phases. In a more refined non-ferrous metallurgical age, we shall undoubtedly see the manufacturing conditions and thermal treatment also specified with precision.

The British Institute of Metals, at the suggestion of Dr. Rosenhain, of the National Physical Laboratory, has taken up the question in co-operation with a committee from several of the British technical and scientific societies. I believe that the subject is of such great importance and has so many aspects that I would advocate this society taking the initiative in America in the formation of a joint committee on non-ferrous nomenclature, comprising representatives from the interested societies in America.

* Abstract of Paper presented at the Annual Meeting of the American Institute of Metals, Chicago.

Making an External Friction Clutch.

By Arthur Greenhalgh.

These clutches are made in various sizes and weights, from two or three hundredweights to as many tons. They are made in different ways, the smaller ones in green sand from a pattern, the larger ones from strickles in green sand and then dried, or in loam. The one here described is made in loam, and weighs about 50 hundredweights. It is of a cup shape, with a boss at the bottom side.

The first thing the moulder has to do before he can commence is to make the necessary plates which he will require. These are three—a flat one to build the bottom upon; a circular binder ring or plate to be built up with the bricks to strengthen

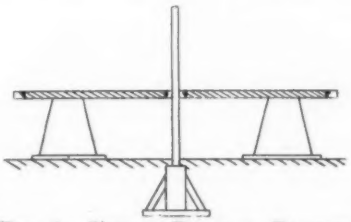


FIG. 1.—BOTTOM PLATE IN POSITION.

the sides; and a plate for the top. A number of holes must be made in the top plate for runners and risers; also about six slot holes must be made in this plate six or seven inches long by an inch in diameter for the purpose of putting bolts through which will be needed to fasten the grid for the lifting of the inside of the cup.

These being ready, the spindle is put in the spindle socket, which is fixed in the floor so that the bottom plate can be put down at a comfortable working distance from the floor (Fig. 1). After the plate has been fixed in position, a thin layer of loam is placed on the plate, and upon this is placed a layer of bricks. The bricks must not be placed close together, but left about an inch apart all round, the spaces being filled with loam. Another layer of loam is placed on the bricks.

The boss, which is of solid wood, with a hole put

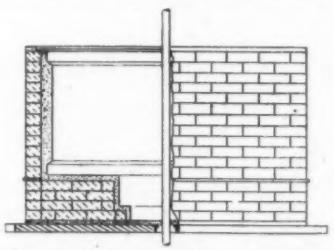


FIG. 2.—BOTTOM HALF OF MOULD READY FOR STOVE.

through the centre for the purpose of fitting on the spindle, is then put on the spindle and made to rest firmly on the loam. Another layer of bricks is laid on, to come within an inch of the boss, in a similar manner to the bottom layer, the spaces between the boss and bricks being filled with loam. This process is carried on to within half an inch of the top of the boss. The top layer of bricks must be only half-filled in with loam, the other half with cinders, which must be carried off to the outside of the mould. The whole is then covered with loam and the mould is ready to receive the ring plate. After this has been done the strickle is put on the spindle and the bottom of the mould is strickled up level with the top of the boss.

The next part of the job is bricking up the side by working the strickle round, and building a circular wall to the required height all round within

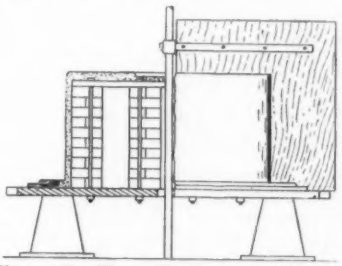


FIG. 3.—TOP PART OF MOULD READY FOR STOVE.

an inch of the face of the strickle. When the mould has been bricked all round, a daubing of stiff loam is placed on with the hand, and then the mould is strickled up in soft loam. When the mould has been strickled up as smooth as possible, the strickle is taken away and the mould is then lifted over the spindle—which must not be disturbed—and taken away to the stove to dry (Fig. 2).

The top plate can then be put on the logs and the strickle fixed in position on the spindle. The face of the strickle will come within two inches of the plate, which should have small spikes, about an inch in length, all over it. A layer of stiff loam is then placed over the plate covering the spikes, care being taken to keep the runner and other holes open, which can best be done by placing wooden

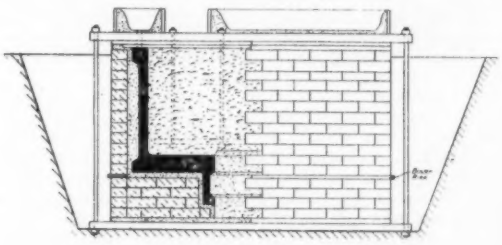


FIG. 4.—MOULD READY FOR CASTING.

pegs in them. As the mould is being built up, five or six pillars of whole bricks are placed in a circular position, resting solidly one upon another, the bottom one resting upon the plate itself. These pillars are for the support of the grid, which is used to keep the cup part of the mould in position; without it, this part of the mould would all drop off when the plate is turned over.

When the mould has been built to within an inch and a half from the strickle, the latter is pulled off

and the pegs pulled out. The grid is then put on the bricks, care being taken to see that the grid will give support to all the bricks. After the grid has been set right it can be fastened with bolts, which go through the mould and are fastened on the under side of the plate. When the grid is screwed up tight it should rest upon the brick pillars and keep the whole mould tight. The strickle will now be returned to position, when it should leave about three-quarters of an inch between the grid and strickle, which must be filled in with stiff loam, afterwards strickled up with soft loam. When this has been done the strickle is taken away, the runners and risers opened out, and then it is ready for the stove (Fig. 3).

When both parts have been thoroughly dried they are brought from the stove and rubbed smooth with sandpaper, and afterwards given a good coat of blackwash and again put in the stove. Preparations can then be made for casting. A hole is dug in the ground deep enough and wide enough to allow the mould to go in. The bottom must be softened up so that the mould can bed itself. The bottom part, when properly dried, is placed in the hole and the centre core for the boss fixed in position. The hole round the mould is filled with sand and rammed up to where the cinders come to the side of the mould. A few more cinders must be placed all round the mould here and the air brought through a pipe to the surface. The hole can then be rammed to the top and the top tried on; if it fits right it is closed, the runners and risers made and then weighted up. As an alternative to weighting, the top part can be put on before the hole is filled in and the two parts can be fastened together by bolts or cramps fixed on the snugs of the plates. The mould is then ready for casting (Fig. 4).

Repairing and Maintaining Crucible Furnaces.

By Walter J. May.

Wherever great heat is generated, any material subjected to it must be more or less injured, but where solid fuel containing ash and material likely to flux either the firebricks or the jointing material used in putting them together is used, the life of the furnace walls becomes considerably shortened. Neglect in operating the furnaces also accentuates the damage, and after a time the conditions become such that the weight of fuel used is out of all proportion to the quantity of metal melted.

The walls of any crucible furnace should be kept clean, and while still hot and plastic the adherent slag or clinker should be removed with a suitable implement, a boiler-furnace "slice" of suitable length being as good a thing as any for the purpose if the edge is kept in proper condition. To knock or chip off slag when it is hard and practically cold destroys both bricks and tiles, as the slag adheres so firmly that part of the firebrick comes off with the pieces of slag. Not only does this reduce the thickness, but it also removes the face of the firebrick and renders what lies behind more amenable to the destructive action of both slag and gases.

The careful furnaceman will run the slice round the walls while the slag is hot and easily removed; he will see that his coke is clean, and report the fact if it is not, and if artificial blast is used he will use only the amount which produces the effect needed. In addition, he will rarely get metal into the fire or allow any of the other little things which assist in destroying the furnace walls and, what is of importance, he will daub up any bad or weak places before serious damage takes place.

In building any kind of furnace, of course, the best materials should be used; but this does not necessarily mean that the most expensive are the best. Good workmanship is also essential, this having a bearing on both first durability and subsequent repairs. The brick or tile linings should be put in with a view to renewals where necessary at any future time, care being taken that the bricks are squarely made and of uniform quality. The joints should be as thin as possible, and the jointing material as non-fusible as possible, and free from anything liable to act as a flux in the presence of intense heat, because in cases where this occurs the bricks will also fuse into a hard mass, rendering repairs difficult. When this occurs practically new linings instead of repairs have to be dealt with, while in some instances rebuilding the furnaces from the fire-bar level becomes necessary.

The better method of dealing with crucible furnaces is to clean off adherent slag and any flaked firebrick, and then to well wet the surface with thin clay-wash, the furnace, of course, being cold at the time. When this has been done, well-ground gannister, as used for steel furnaces and kneaded into a putty-like mass, should be applied, and well beaten in until the furnace assumes its original shape, the surface being made smooth as a matter of course. After drying for some time, according to the thickness of the gannister, a gentle fire should be run for some hours, and after this a strong fire should be made to fuse the lining together.

In some cases the replacement of worn bricks by sound ones has to be made, and where this is done the amount of wear the old bricks have had has to be taken into consideration, as obviously a new brick will be wider than a worn one. For this reason the depth of the hole left where the old brick is taken out has to be carefully ascertained, and after making a small allowance for the jointing material (generally well-soaked fireclay), which will be forced back, the back edge of the brick must be cut away so that when in position the edge inside the furnace will be level with the rest of the brickwork. The hole must be thoroughly wetted, as also the new brick, and then with a fair amount of fireclay worked into a sloppy state the new brick should be forced into position, rapping it back with the handle of the hammer. Some little care is necessary in doing this to avoid breaking the brick. Where the top of a furnace is of brick instead of iron plates or tiles, only ordinary brickwork is needed, but the work must be well done in replacing anything on furnace tops, as accidents easily arise.

In replacing tile linings care must be taken to very thoroughly grout in the backs of the tiles, and then to give this a fair time to dry before firing the furnace strongly, as steam plays funny pranks when it is generated in closed spaces. There is, of course, little fear of explosive energy being formed, but the force which is generated is usually enough to cause considerable dislocation of brickwork.

It may usually be taken that with good materials and workmanship that crucible furnaces of the ordinary form will rarely need rebuilding below the fire-bar level, and even this should only occur at long intervals where the furnaces are in constant work; but as the heat is certain to cut away the bricks at the flue aperture, this will need renewing to keep the draft regular. To this end the arrangement should be such as to make the job fairly easy in view of the frequent renewals; but otherwise there is no difference in doing the work at this point from doing it in other parts of the furnace.

The Behaviour of Cast Iron under Differing Conditions.

Notes on Constituents, Analysis, Fracture and Grade.

By Sidney G. Smith.

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Although cast iron has for so many years been used for engineering purposes, it is surprising what a small amount of definite knowledge has been gained regarding its true properties and possibilities. It is only during recent years that real earnest intelligent research work has been attempted. Steel has made rapid and successful strides, but cast iron remains almost as much a mystery as ever. It is true that

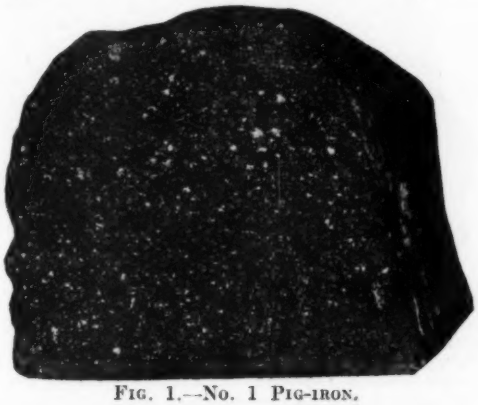


FIG. 1.—No. 1 PIG-IRON.

economy and the increased production of cast iron have received attention and no expense has been spared in improvements, alterations, and developments in that direction; but, all that does not help to an understanding of the hidden possibilities and impossibilities of the product. The chemist can give the analysis and percentages of contents of any class

FIG. 2.—No. 2 PIG-IRON.

of iron, and can possibly give the influence of one content upon the other, and state almost definitely the conditions of the iron under certain circumstances in terms that are intelligent to the student, but that is almost as far as he can go. That in itself, of course, is no mean accomplishment.

We can now obtain analyses galore of any and all the irons made in the country. Analysis are becoming cheap and plentiful. But analyses, although necessary, are by no means everything, as those who are now engaged upon important research work are discovering, much to their surprise. Recent discoveries, accidental and otherwise, are proving that there are numerous conditions to consider quite apart from analysis. Professor Howe, after making some 3,000 experiments with cast iron, said he knew very little about the subject, and the writer has no doubt that Professor Howe's experience has also been the experience of many other devoted scientists seeking definite laws and results.

One may sometimes stand at the tapping hole of the blast furnace anticipating what class of iron will come. Some furnacemen profess to be able to say what kind of iron it will be; they are guided chiefly by the colour and condition of the slag, coupled with knowledge of the burden, blast, and general working of the furnace. Others, rather more cautious, say

FIG. 3.—No. 3 PIG-IRON.

they can tell better when they see the metal running, and some who are still more cautious say they can best judge when they see the fracture. The chemist will probably say he can decide when he knows the analysis. Now sometimes most of those mentioned can predict somewhere near the class of iron, as they possess this capability from many years' experience in one district at the same furnace; but over and over again disappointments and deceptions occur, even with those who have spent a lifetime at furnaces. However, the metal is generally left unclassed until the fracture can be seen, or the analysis has been completed; the iron is then either numbered or classed by analysis, though the latter method is not yet general.

With the advent of the foundry chemist there will arrive a tendency to abolish or disregard the usual numbers, and procure iron by analysis alone. The writer is quite in agreement that foundry iron should

be purchased and mixed by analysis, but contends that the numbers should approximately represent the analysis in the same brand, Numbers vary with fracture, as they should do; but it is urged that fracture is not reliable and that it often occurs that a No. 3 iron can be taken for a No. 2, and a No. 4 for a No. 3, and so on; also that the contents vary to a large extent in the same numbers. But these statements go to prove that numbers evidently represent an approximate analytical content. I have heard that many iron producers, if asked the compositions of Nos. 1, 2, 3, or 4 pigs, cannot say, but point to the samples. If that is true, it is to be deplored. Since the writer has made a study of iron mixtures, he has always associated the numbers with analysis, fracture, tensile strength, transverse strength, and resistance to pressure, with due consideration to thickness, cooling and design.

The analysis and physical properties of each number will vary according to the district in which the iron is made, also the mixture of different ores and ironstone of which the burden is composed, and for the purpose in view may be taken an average or typical analysis of each number of ordinary irons, such as Cleveland and Derbyshire. Hematites and special irons are not included at present.

The approximate analysis of a No. 1 would be :—

	Per cent.
Combined carbon	0.15
Graphitic carbon	3.30
Silicon	3.00
Manganese	1.00
Phosphorus	1.50
Sulphur	0.02

FIG. 4.—No. 4 PIG-IRON.

This analysis suggests at once a metal that is dead soft, and without the addition of any other iron it would be of very little service in the foundry. The silicon content is high, and as the carbon may sometimes reach or exceed the saturation point, it would border on and be a kisky iron, due to the high silicon precipitating a still higher carbon into graphite flakes. In normally cooled iron these large flakes can be seen throughout the matrix on examining the fracture, and often when such an iron is falling in temperature, it being as a rule of a dazzling whiteness when tapped from the furnace, these graphite flakes can be seen rising from the iron into the air, which indicates that in cooling it throws off the carbon it cannot contain at the lower temperature. Such an iron would give very unsatisfactory transverse tensile or deflection tests, and under pressure in a thick casting it would sweat as though it were full of open pores, which would be due to the large flakes of graphite entirely breaking up the continuity of the structure. Also, although it is an iron that has the least contraction, it has a greater liquid shrinkage, and is of low specific gravity. It probably has a higher melting point and retains its heat longer than the higher numbers.

The analysis of a No. 2 would be approximately :—

	Per cent.
Combined carbon	0.20
Graphitic carbon	3.15
Silicon	2.75
Manganese	0.75
Phosphorus	1.50
Sulphur	0.03

FIG. 5.—No. 5 (FORGE) PIG-IRON.

This suggests a very soft open-grained iron, useful for very thin ornamental and thin-section castings, such as connections for heating apparatus, grate work, etc.; but it is of little service where stress of any kind is required. It contracts rather more than a No. 1, and its liquid shrinkage is less, its matrix a little closer, its melting point lower and specific gravity higher. It is very soft to the tool when machined, but does not give a smooth, even surface, and is of little service for hard wear.

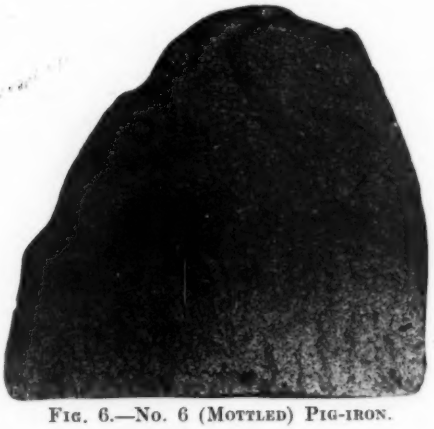


FIG. 6.—No. 6 (MOTTLED) PIG-IRON.

The approximate analysis of a No. 3 iron would be :—

	Per cent.
Combined carbon	0.25
Graphitic carbon	3.00
Silicon	2.50
Manganese	0.65
Phosphorus	1.50
Sulphur	0.04

This iron is serviceable for such castings as small pulleys, thin pipes, etc. It is closer in grain, will endure frictional and surface wear longer than the more open numbers, and has less liquid shrinkage. There is a slight increase in contraction, and it gives more satisfactory tests than a No. 2 iron.

The analysis of a No. 4 iron would be approximately :—

	Per cent.
Combined carbon	0.35
Graphitic carbon	2.80
Silicon	2.00
Manganese	0.60
Phosphorus	1.50
Sulphur	0.05

This is the most serviceable iron for general purposes. It is close-grained, and the graphitic carbon is in a more finely-divided state than in the lower numbers. It has the least liquid shrinkage of any numbers above or below; it machines well, gives a smooth, clean surface, will stand shock, wear and tear, and give satisfactory tensile and transverse tests with good deflection. It is suitable for many engine and machine parts, gearing, columns, stanchions, etc.

The analysis of a No. 5, or a forge iron, would be approximately :—

	Per cent.
Combined carbon	0.65
Graphitic carbon	2.50
Silicon	1.70
Manganese	0.55
Phosphorus	1.50
Sulphur	0.06

We are now nearing an iron that is strong and bordering on hardness. It is suitable for very thick castings, and with slow cooling machines clean and close, but is of little use for small or thin castings. It gives good tests. The contraction increases as the numbers rise, and the point is passed where liquid shrinkage is least.

Mottled iron would give approximately the following analysis :—

	Per cent.
Combined carbon	1.50
Graphitic carbon	1.50
Silicon	1.00
Manganese	0.50
Phosphorus	1.50
Sulphur	0.08

It is between a close No. 5 iron and a white iron. It is a very unsatisfactory iron and difficult to manipulate, chiefly owing to the white iron being in patches. Used alone it is very limited in its application for any kind of castings, owing to its hardness and brittleness.

The analysis of white iron would be approximately :—

	Per cent.
Combined carbon	3.00
Graphitic carbon	nil
Silicon	0.70
Manganese	0.30
Phosphorus	1.50
Sulphur	0.10

It is extremely hard and brittle, and will not machine. The contraction and liquid shrinkage are much more than with grey iron. Mottled and white grades are of some service for weights, wire guides and guides in small merchant mills, pile shoes, etc. For many kinds of work they may be judiciously mixed together; or by remelting they may with advantage be mixed with special irons such as cold-blast and Swedish irons, hematite, silicon, or glazed iron, manganiferous iron, or even spiegeleisen.

The following table shows the formulæ, atomic weights and specific gravities of the constituents of cast iron. It must, of course, be remembered that these constituents exist in the iron not as elements but as compounds.

Name.	Symbol.	Atomic weight.	Specific gravity.
Phosphorus	P	31.00	1.8
Sulphur	S	32.00	1.97
Carbon (Graphite)	C	12.00	2.20
Silicon	Si	28.10	2.49
Iron	Fe	56.00	7.86
Manganese	Mn	55.00	8.00
White pig-iron	—	—	7.55
Grey pig-iron	—	—	6.85
Grey iron melts at about	1,250 deg. C. or 2,282 deg. F.		
White iron melts at about	1,150 deg. C. or 2,102 deg. F.		

It has been the writer's fortune as journeyman moulder and foundry foreman, to be employed upon various kinds of work in both sand and loam, in different parts of the country; and during fifteen or more years of varied experience with moulds cast vertically, both thick and thin, in dry sand and loam, with iron of different composition and castings of great thickness and depth, the difference in liquid shrinkage with iron of various numbers has been very noticeable. This phase of iron foundry has not been dealt with to any great extent by metallurgists or others. Of course, the phenomena in question can only, or at least better, be observed in practice, when dealing with liquid metal in large bulk, during feeding, etc. The writer's statements upon this matter, however, are offered for what they are worth, and until opportunity arises to prove or disprove them.

The following six diagrams, which represent 12-in. cubes, show the analyses and numbers of the different grades of iron. The dotted lines indicate approximately the comparative differences in liquid shrinkage and contraction of each grade, the curved line representing the liquid shrinkage, observable as "sinkage"; and the dots the spongy or hollow parts. The difference of contraction in relation to section or thickness will be dealt with elsewhere.

It will be noticed that in each of these irons the metalloids are under 10 per cent., thus leaving iron by differences over 90 per cent. It is chiefly due to the variations of the metalloids and manganese that different grades of iron are produced, and these depend upon the amount and composition of the iron ore or stone, fuel and fluxes comprising the burden of the blast furnace in which the iron is made; and also the temperature, blast pressure, and general working of the furnace, and other matters known and unknown to iron makers.

With normal cooling the proportions of the metalloids have considerable influence upon the temperature of the iron. For example, a No. 1 containing a high percentage of silicon and carbon will retain its heat much longer than the higher numbers, both in the liquid and solid condition. A No. 4 iron will solidify quicker, and a white iron still quicker.

It may be urged that the lower numbers are capable of a higher temperature, which would account for the slower cooling. That may be so, but it does not always follow. For example, a No. 1, a No. 4 and a white iron of the same brand would each contain nearly the same amount of phosphorus, and would melt each at the same temperature; but were a 12-in. cube cast from each it would be found that the white iron solidified first, the No. 4 next, and the No. 1 last. As another example, we may take a No. 1, a white iron and a special iron containing a very low percentage of impurities (such as a Swedish iron), and melt each to a dazzling whiteness; in this case the special iron would need more fuel than the No. 1, or the white iron, and if

5 cwts. of each were poured into a long, level, open sand runner, it would be questionable which would run farthest; but cast each of these metals into a 12-in. cube mould and it would be found that the No. 1 would retain its heat very much longer than the white or special iron. The latter instance is given because of the writer frequently being asked whether silicon really promotes fluidity. In practice, presumably, there is some doubt about it. A high percentage of silicon will both promote and prolong fluidity if the iron is well covered in the ladle and poured into covered moulds. If such metal remains uncovered or is poured into open-sand moulds there is a tendency to crust very rapidly; this is due to the absorbing of oxygen from the air, for which silicon has a very strong affinity.

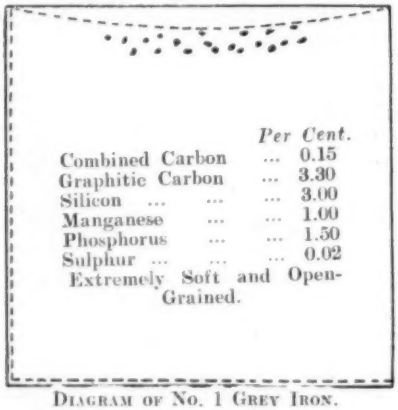

Per Cent.
Combined Carbon ... 0.15
Graphitic Carbon ... 3.30
Silicon 3.00
Manganese 1.00
Phosphorus 1.50
Sulphur 0.02
Extremely Soft and Open-Grained.

DIAGRAM OF No. 1 GREY IRON.

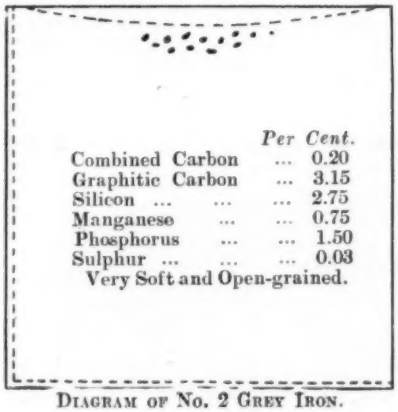

Per Cent.
Combined Carbon ... 0.20
Graphitic Carbon ... 3.15
Silicon 2.75
Manganese 0.75
Phosphorus 1.50
Sulphur 0.03
Very Soft and Open-grained.

DIAGRAM OF No. 2 GREY IRON.

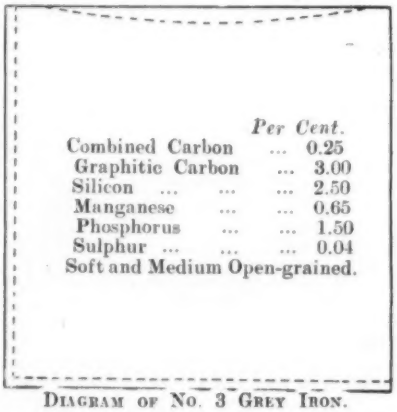

Per Cent.
Combined Carbon ... 0.25
Graphitic Carbon ... 3.00
Silicon 2.50
Manganese 0.65
Phosphorus 1.50
Sulphur 0.04
Soft and Medium Open-grained.

DIAGRAM OF No. 3 GREY IRON.

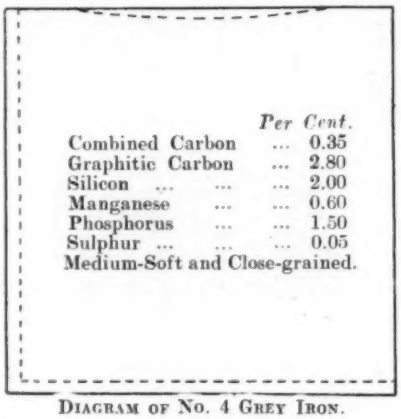


DIAGRAM OF No. 4 GREY IRON.

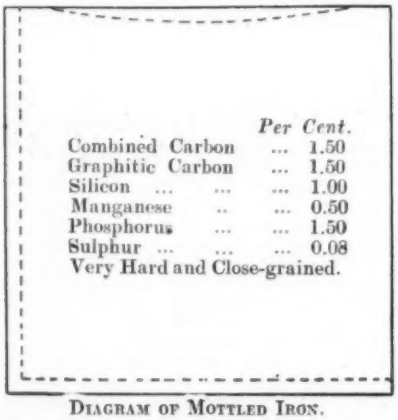

Per Cent.
Combined Carbon ... 1.50
Graphitic Carbon ... 1.50
Silicon 1.00
Manganese 0.50
Phosphorus 1.50
Sulphur 0.08
Very Hard and Close-grained.

DIAGRAM OF MOTTLED IRON.

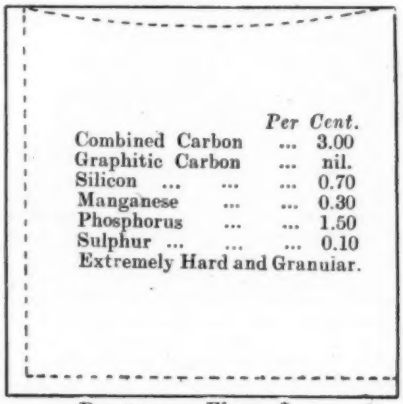

Per Cent.
Combined Carbon ... 3.00
Graphitic Carbon ... nil.
Silicon 0.70
Manganese 0.30
Phosphorus 1.50
Sulphur 0.10
Extremely Hard and Granular.

DIAGRAM OF WHITE IRON.

Foundry Sands and their Treatment.

By Algernon Lewin Curtis, M.E.

(*Continued from page 667.*)

Practical Methods of Testing Moulding Materials by Heat.

Having briefly described the source of heat, and an apparatus for measuring same, it now remains to show how suitable tests can be carried out on samples of moulding materials and the methods of conducting same.

If it is desired to test a new sand or moulding material, the sample should be first dried for one hour at a temperature not exceeding 100 deg. C. in a steam or gas-heated oven. This oven answers the double purpose of drying material in its raw state and also test-pieces. After drying, the material should be well rubbed in a pestle and mortar and sieved through a 50-mesh sieve, all the material retained on the sieve being crushed or milled until it finally passes through. It is advisable for purposes of reference to take the surface factor of the material in its original state before crushing. A useful weight to be taken for a sample is 100 grammes, which allows sufficient material for the test-pieces and microscopic specimens. After drying and before crushing, samples for microscopic examination must be taken.

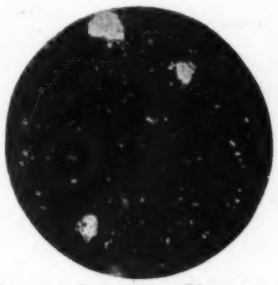


Fig. 1.—Imperfect Micrograph of a Moulding Sand.

This will be referred to separately. Enough water should then be introduced into the sample to make it cohesive enough to work, this being done preferably in a porcelain dish, from a calibrated burette; then, after noting the amount of water the material has taken, the whole mass must be mixed and incorporated 400 times, finally making eight test-pieces in the core-box previously illustrated. The reason why eight test-pieces are necessary instead of one is that the first test-piece is for use as a sample of material in its natural state for microscopic examination, and not to be put under the blow-pipe; the second test-piece is for insertion in the oxygen furnace, while the remaining ones are to be put under the blow-pipe at temperatures varying between 1,200 deg. C. and 1,700 deg. C. in units of 100 deg. C. An extra specimen can be made as a spare in case either of the others become broken in handling. To make the test-pieces, the core-box is laid on a 3-in. × 1-in. glass slide and the material introduced evenly, then rammed uniformly all round, being finished with a straight-edge and trowel. A few gentle raps on the core-box allows it to be removed, leaving the test-piece on the glass slip. After the test-pieces are made, a small gummed label is stuck on each glass slide bearing its number. A good method of classifying such test-pieces is to give each a number corresponding to a page in a specially-printed test book, in which all the information relating to a particular moulding material can be entered for future reference.

When taking the fusing points of individual specimens, it is best to lay the test-piece on a firebrick at right angles to blow-pipe, travelling it up and down by means of the balanced carriage. If, however, it is desired to test several specimens of different material at once for purposes of comparison, they can be laid in a row in a line with blow-pipe at right angles to the firebrick. In this instance, where the testing of a single specimen is concerned, the travel of carriage is arranged to be equal to 1½ times the length of test-piece. This is to allow room for Seger cones used for adjusting the pyrometer.

Fig. 2.—Section Lifter.

Having now ascertained that all rubber connections are safely wired, the coal-gas is turned on and ignited at the blow-pipe. It should be noted that when using an oxy-coal-gas blow-pipe, coal-gas must always be turned on first and lighted before turning on the oxygen. The oxygen cylinder is then unlocked, previously observing that the automatic regulator tap is closed, also the oxygen shoulder tap marked "oxygen." Whilst the gas jet in the blow-pipe is still alight, the automatic regulator tap on the oxygen cylinder can be turned on, gently at first in order to fill the rubber tubing, then completely on. The regulator having been set at the pressure desired, the shoulder taps, which should always be placed at the operator's right hand, are adjusted so as to give the flame required. The pyrometer lamp should always be at the operator's left hand in order to keep a constant watch on the tip of the lamp flame. Directly the oxygen shoulder tap is turned partly on, rapid combustion takes place. This must be adjusted on to a Seger cone till the latter just melts, the number of cone or its refractory quality necessary being found by experience. In other words, if a sand contains many fluxes and is, in the opinion of the operator, a low-grade material, then a cone which will melt at the temperature of cast iron, 1,250 deg.

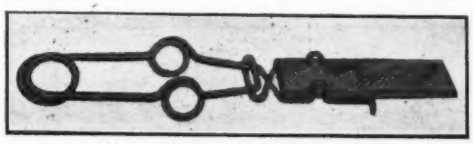


Fig. 3.—Boston's Forceps.

C., viz., cone number 8, should be tried first. Having arranged the flame of the blow-pipe to impinge itself at its hottest part on to the Seger cone, directly that begins to bend over, the flame must be adjusted so that the colour of the oval patch in the instrument matches the heat image from the cone itself. If it exceeds 1,250 deg. C., it will at once melt the cone, and be observed on the scale of pyrometer too; then the oxygen and coal-gas supply must be adjusted accordingly, or *vice versa*. Directly the flame has reached uniformity the carriage with the test-piece is pulled forward by the lever, and kept in that position until the colour mass of the heated test-piece matches the oval patch. When these two colours coincide the carriage is travelled under the blow-pipe very slowly, once over

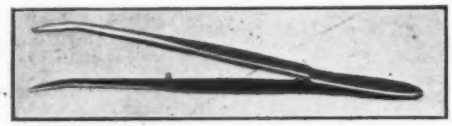


FIG. 4.—BENT FORCEPS.

the specimen. The specimen should be watched all the time through coloured glasses, and it might be stated here that the use of the darkest blue or "London smoke" glasses possible to see with are the best, as the bright glow from an oxy-coal-gas or oxy-acetylene blow-pipe is very powerful, and it is necessary to watch very closely whether fusion is taking place on the test-piece under the flame. The operator should have a stop-watch close at hand so that the total time the test piece has been subjected to a particular heat can be noted and recorded. When the necessary time is completed, the oxygen is shut off by closing the shoulder tap, and the specimen is then removed from the flame. Coal-gas is then shut off and the test-piece examined by a pocket lens. If its surface is found covered with a glass, it has probably melted at a lower temperature, and a fresh test-piece, therefore, must be used with a lower Seger cone, and the oxygen and coal-gas adjusted accordingly. If, however, there has been little or no sign of fusion, a higher cone can be used, and the flame of the blow-pipe increased. Directly a test-piece has been fused, full particulars of its temperature, etc., should be recorded in the test book.

The Examination of Moulding Sands and Materials Before and After Heat Treatment.

It would be an advantage to the founder (before requisitioning moulding sands or materials) to adopt some system other than the general methods at

FIG. 5.—MICROSCOPIC NEEDLE.

present employed, for the purpose of ascertaining their true value. At first sight this may appear outside a foundryman's jurisdiction, but the high grades of moulding material now demanded for casting steel and pure copper, necessitate ways and means by which not only may the most suitable materials be easily procured, but their physical qualities be as easily proved. In the previous article the writer made reference to a method of testing the refractory qualities of a moulding sand or material. In the present and subsequent chapters, micro-photographs of cores or test-pieces made from moulding materials in everyday use will be shown, to prove that the refractory degree of any sand mixture can be easily arrived at in the laboratory, and controlled within wide limits.

Possibly one reason the microscope has not become more popular in foundries is the trouble and difficulty experienced with illumination. Without resorting to the miscroscope and a camera, it is impossible to compare accurately the physical qualities of moulding materials, especially those physical changes which take place in such materal after being exposed to different temperatures; but it should always be borne in mind that without perfect illumination a microscope is practically useless, though it is unnecessary to employ electric light in order to obtain good working results, as an incandescent gas lamp will be found to answer every requirement.

Perhaps some founders have hitherto objected to the microscope (as far as moulding sands or materials are concerned), on the grounds that micro-photographs like Fig. 1 are of little practical use, and consequently the instrument would scarcely be of any value in the foundry. In this they may be right, because a micro-photograph similar to Fig. 1 does not convey to the foundryman much which he can employ in a practical manner. All Fig. 1 shows is a mass of particles or grains of unequal size and shape; a condition readily perceived by the use of a common high-power pocket lens. The reason why it does not give any detail is because the proper apparatus has not been employed, especially that

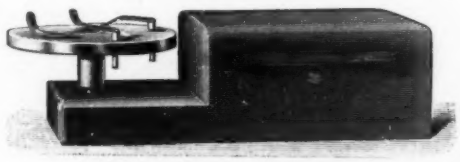


FIG. 6.—IRON TURNTABLE.

part pertaining to illumination. It is, of course, obvious that the natural colours of minerals contained in a moulding sand, as viewed under the microscope, cannot be transmitted to paper without considerable expense and trouble; but definition and detail of crystals can be obtained to make comparison and identification comparatively easy.

As it would be impossible to describe or compare the physical qualities of a moulding sand or material without the medium of a micro-negative or photograph, the founder should be able to operate a camera with a view to checking his own sands. Some people imagine that microphotography is akin to a secret process, hidden from any but the select few. This is a somewhat ridiculous notion, for it can be successfully practised with a home-made camera, provided the person has the time and means to make the apparatus. It is best, however, at first to requisition a $4\frac{1}{4} \times 3\frac{1}{4}$ in. quarter-plate camera and not be handicapped with anything other than the business of operating it.

One contention, perhaps rather common amongst founders, which might be referred to here, is that the relative value of science in the foundry, as applied to moulding materials, is small. Some founders no doubt think that first-class castings can always be made without trouble, and without a knowledge of the former subject. Assuming such an argument to be true, it then resolves itself into a question of "degree" of first-class castings; while freedom from trouble is only generally associated with many years'

experience on the part of the founder, and the life and uniformity of his sand pit. When it can be stated on authority that the "degrees" of first-class castings are not exceeded in numbers by the letters of the alphabet, and in steel castings their name is legion; also that good uniform strata in sand-pits are few and far between, then the value of practical science in the foundry will be better appreciated.

An ordinary microscope may be used for the taking of microphotographs of moulding sands or materials, with its objectives and substage condenser, but it requires to be very accurately fitted to, and connected with, the camera that is employed, special care being taken in exact centring. Before microphotographs, however, can be taken of moulding sands or materials, it is necessary to know how to prepare and mount the samples. This particular work requires a certain amount of dexterity and skill, but can soon be learnt by a little practice.

So far as the microscopic examination of these materials is concerned, two different methods have to be employed. The first for examining such material in its natural or loose state, the second when materials are made up in the form of cores or test pieces and exposed to different temperatures. The former method involves the use of some mounting medium. Polarised light is necessary for micro-examination, and an Abbe illuminator for the taking of micro-photographs. The latter method of

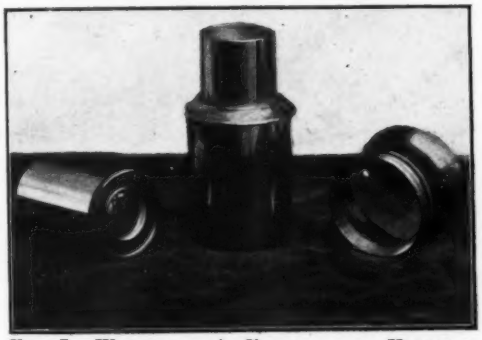


FIG. 7.—WATCHMAKER'S EYEGLASS AND VARIABLE MAGNIFIER.

examination necessitates the use of test pieces or specimens, these being top illumined with a powerful condenser.

To get a good and accurate working knowledge of the origin and character of a moulding sand or material by the first method, it is best to employ very thorough sampling. This can be done in the following way:—

1*st Sample Slide.*—Material in its natural state.

2*nd Sample Slide.*—Material retained on a 50-mesh sieve.

3*rd Sample Slide.*—Material retained on a 100-mesh sieve.

4*th Sample Slide.*—Material sieved through a 100 sieve.

5*th Sample Slide.*—Material sieved through a 100-mesh sieve, elutriated, filtered, dried and the filtrate mounted.

For the preparation and mounting of samples of moulding sands or materials the following apparatus and materials are necessary:—

(1) A nickel-plated section lifter (Fig. 2).

(2) A pair of Boston's forceps for holding slides horizontally (Fig. 3).

(3) A pair of bent forceps with fine points (Fig. 4).

Fig. 5.

(5) An iron turntable with brass disc (Fig. 6).

(6) A watchmaker's eyeglass and variable magnifier as in Fig. 7.

(7) A box containing a set of 21 bottles of liquids with refractive indices varying between 1.447 to 1.83, Fig. 8 (prepared by Dr. F. Krontz, Bonn, Germany).

(8) Three sieves 50, 100 and 200 mesh, the latter silk.

(9) Several hundred rectangular adhesive slide labels $\frac{7}{8}$ in. by $\frac{3}{4}$ in., with five printed lines.

(10) Six assorted watchglasses.

(11) One gross of vulcanite cells or rings $\frac{3}{4}$ in. outside, $\frac{5}{8}$ in. inside diameter.

(12) One gross of 3-in. by 1-in. glass slips or slides (Chance's flattened crown).

(13) Half an ounce of $\frac{3}{4}$-in. cover glasses (circles), size No. 1, half an ounce of $\frac{3}{4}$-in. cover glasses (circles), size No. 2.

(14) Several small bell glasses for use when mounting slides.

(15) A bottle of balsam in benzol.

(16) A bottle of Miller's cement.

FIG. 8.—DR. KRONTZ'S SET OF 21 LIQUIDS.

(17) A bottle of finishing cement.

(18) A large bottle of benzine.

(19) A small bottle of benzol.

(20) A bottle of Canada balsam (liquid), and a bottle of dried Canada balsam (crystals).

(21) Several small glass rods.

(22) A pipette stoppered bottle (Fig. 9).

(23) Half a dozen sable lining brushes.

(24) A small slide cabinet having twelve trays capable of holding 144 slides (Fig. 10).

The above apparatus and materials can be obtained from such firms as Messrs. Wm. Watson & Sons, Limited, London.

The chief object in mounting samples of moulding sands or materials is to preserve them for future reference, as well as to obtain the greatest display. Different moulding sands or materials require different mounting media. This can be determined by using the liquids as supplied by Dr. Krontz, but the writer's experience has been that it is best to begin mounting moulding sands or materials first in "balsam in benzol," then work upward or downward as it may appear necessary, using the different liquids of Dr. Krontz until the correct R. I. has been arrived at. It is, of course, absolutely necessary that

great cleanliness be observed during mounting, as a film of dust will prevent good definition, and perhaps spoil the slide. A rectangular piece of thick plate-glass, previously levelled up on a double sheet of white blotting paper, will be found of great service; if the latter is spread out upon the table used, then everything can be kept clean from the commencement.

Cover glasses can be kept with advantage in a glass dish, in a solution of nitric acid and water, two of water to one of acid. This will help to remove any marks that may be on the surface, and the glasses can be taken out as required. They should then be immersed in methylated spirits or pure alchohol, and finally cleaned between the fingers with a silk handkerchief. At first some breakages will be experienced in handling No. 1 cover glasses, but after a little practice the extra results obtained by the use of such thin glasses will be amply repaid. Soda in water is a good medium to clean 3 in. by 1 in. glass slips, which should afterwards be wiped with a clean linen handkerchief, moistened by methylated spirits.

FIG. 9.—PIPETTE STOPPERED BOTTLE.

To prepare samples of moulding sands or materials for mounting by the first method, 100 grammes should be dried at 100 deg. C. for one hour, in order to have all the material of the same degree of dryness. After drying, the sample should be slightly rubbed in a mortar, then thoroughly mixed. This mixing operation can be carried out by pouring dried material into a funnel and placing underneath this a receptacle, moving the latter in a circle until the funnel is empty, repeating the operation for ten minutes or so. Mixing by this means gives a fairly uniform sample. The material is then placed in a porcelain or glass dish and covered with benzol, and when dry (*i.e.*, the spirit having evaporated) divided into ten different parts.

A 3-in. by 1-in. glass slip is then cleaned and a vulcanite ring fixed in its centre. This is done by moistening the bottom of vulcanite ring with Miller's cement, using a sable brush, then placing the ring on slide with the bent forceps, and pressing it home with the microscopic needles. Two more rings should then be placed on the slide in a line, and a second glass slip laid on these, upon which is laid a small weight in order to make the ring stick firmly. In a few minutes the ring will be set, and the slide can then be put in the turntable, washed, and a further ring of the same cement put on the outside of the ring to make it secure. It is best to prepare about a dozen of these slips at one time. Brushes used for applying Miller's cement should be immediately immersed in a dish of benzine, as this cement very quickly sets, making the brushes hard.

A drop or so of balsam in benzol is then introduced into the middle of the cell from a pipette bottle (Fig. 9). The cover glass having been previously cleaned, a small amount of moulding sand or material is then taken up with the narrow end of the section lifter (Fig. 2), and very gently shaken into the medium in the cell by holding the section litter in the left hand and slightly tapping same with a needle point (Fig. 5), held in the right. Very minute quantities of material must be distributed evenly in the media in cell to obtain good results, same being finally adjusted with needle points, using either a watchmaker's eyepiece (Fig. 7), or a small dissecting microscope for this purpose. The introduction of material into balsam in benzol should be such that the latter medium is not quite level with the cell top. The cover glass is then taken from under a bell glass cover,

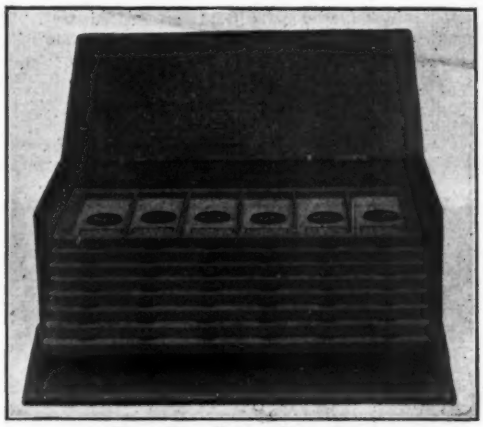


FIG. 10.—SLIDE CABINET.

used to exclude dust, and with a pair of bent forceps (Fig. 4) lifted on to one side of the vulcanite cell or ring, which has been previously moistened with Miller's cement. It is very essential that no air or moisture be contained in either material or medium, or the finished slide will be full of bubbles, and therefore spoiled. After gently pressing down the cover glass on its edges with the needle points, or sable brush handle ends, the slide is removed again to the turntable and a ring of finishing cement is put on. The slide should then be put away in a warm, level place to dry, after first sticking on an adhesive label containing full particulars of the mount.

To prepare the second sample slide of a moulding sand, a further tenth part of the original sample is placed on a previously cleaned 50-mesh wire sieve, and when sieving is complete the material is mixed as before, and the previous operation repeated. Material for slides Nos. 3 and 4 are treated in a similar manner, but slide No. 5 should be put into a beaker with about 50 times its weight of water, thoroughly stirred and the material in suspension poured into a filter, leaving the heavy material behind in the beaker. The filtrate is then dried and mounted. It is best to use two beakers and two filters; the lightest filtrate representing much of the clay substance is thereby obtained.

(To be continued.)

Basic Open-Hearth Steel Castings.*

By H. F. Miller, Junr.

For some years the prejudice against basic open-hearth steel for castings has been gradually decreasing. Acid steel has been used for this purpose much longer than basic steel; and the melters in acid practice had it well in hand when basic steel was first tried. Then the necessity of learning a new set of laws for the production of satisfactory basic open-hearth steel for castings became evident. The first of these laws has to do with the furnace construction. The charge should be melted down as speedily as possible to prevent excessive oxidation.

Furnace Hearth.

The hearth of the furnace is a decisive factor in the production of solid castings. The manufacturer should know the size of the heats he intends to make constantly, and should have his furnace built for that size of heat. The hearth should differ in dimensions from that of a furnace making ingot steel. That is, the bath should be deeper and should have less surface area. A shallow bath permits the slag to come out soon after the steel commences to flow, and thus prevents the additions from going into the steel, or from becoming uniformly distributed should they be put in hurriedly.

Under this head comes the very poor practice of making small heats in hearths of a much larger capacity. If into a 25- or 30-ton furnace only 12 or 15 tons of metal is charged per heat, the proportion of heats that will be wild or show signs of wildness at some time during the pouring will be comparatively large; whereas, if the hearth is charged to capacity, a heat showing signs of wildness will be a rare occurrence.

Influence of Slag.

The nature and action of the slag is an important factor in the manufacture of quiet steel. Slags are usually roughly classified by the melter according to physical appearance, as follows:—

(1) The "dry" heavy slag occurring when there is very little silica present. This is a dangerous slag if not carefully worked. The burning of many furnaces is due to reflection of the heat to the roof by this slag. Another danger is that the melter, deceived by the physical appearance of the slag, may add an excessive amount of fluorspar. This results in the ladle being badly cut and the stopper rod burned off. These disasters can be prevented by a gradual addition of spar until a "wet" slag is created, after which the heat may be worked down as usual. With natural gas the heat will foam for some time.

(2) A "wet" but "lumpy" slag is a good slag with which to work. The lumps of limestone should be broken up with a rod, so that a rocky bottom may be avoided. Otherwise an unbroken lump will choke the tap-hole, so that the flow of the slag being stopped, the steel is left uncovered until the tap-hole can be freed. A large amount of heat is lost from the steel thereby. A lumpy slag can be avoided by charging small-size limestone.

(3) A third slag is the very watery variety, usually occurring when heats melt at high temperature, by reason of the presence of an excessive amount of silica. This slag should have burned dolomite or raw limestone added until a thick slag is made. When the slag is too thin, it will mix with the steel in tapping and a wild steel will be the product. The ladle and stopper rod will be badly scorified, and usually some tons of steel will go into the pit by reason of a burned-off stopper rod.

The ideal slag is heavy and wet with no large lumps. This slag makes an easy heat to work and gives a steel low in phosphorus and sulphur. It requires but a small amount of fluorspar to put this slag in shape for the ladle. A heavy slag of this nature will not mix with the steel, and will generally stay in the furnace until the steel is nearly all in the ladle. It also has the good quality of cutting neither the stopper rod nor the ladle brick. The only objection is that it causes a dirty bottom, and unless a "washout" is made after each heat the bottom will rise to the sill-plate level after a few heats. This result shows very poor practice. No time is ultimately gained by charging up without the usual "washout." If a "washout" from 20 to 30 min. is made after each heat, the furnace will work fast for a much longer time. Moreover, the holes that occur in a "high" bottom will be largely avoided, if the bottom is kept low and clean.

Tap-Hole.

The tap-hole should be kept large and low. The quicker steel gets into the ladle, the more heat is retained. The shorter a spout the better, for the same reason. Moreover, a large tap-hole will not clog up easily if rabbling has to be done; and few "hard" taps will occur. For shutting up the tap-hole magnesite is best, because it does not burn together and make a "hard" tap, nor does magnesite boil out, as may happen when a tap-hole is closed with green dolomite. Burned dolomite, however, may be safely used, the only drawback being an occasional hard tap, due to the burning together of the material.

The foregoing facts are probably known to most smelters; but unless vigilance is constant, one factor is apt to be overlooked. The bottom may be low and the tap-hole all right; but the spout if not smooth at the end may cause the stream to spray over the ladle, thus losing much heat and causing a skull and, perhaps, some misrun castings, all of which could be avoided with a carefully made up spout.

Alloys.

The addition of alloys may be made in the bath or in the ladle. By putting them into the bath, much heat is saved. This is a valuable method where a furnace is working cold or a heat has melted "low" and there is difficulty in getting it hot. The advantage is that the additions are made while the flame is still on the bath, and the loss of the heat in the bath caused by dissolving the alloys can be regained. The objections are:—(1) That a large amount of each alloy must be added, since in this method from 15 to 30 per cent. goes into the slag; (2) that the silicon, reacting, will throw back the phosphorus into the steel. Putting the additions into the steel as it goes into the ladle is the better method. A uniform distribution of alloys is obtained by

* Abstract of a Paper presented before the American Institute of Mining Engineers (Iron and Steel Division).

shovelling the alloys in gradually. If the alloys are added to the ladle, the steel will be helped greatly by first raising them to red heat, especially in winter.

"Soaking."

After the heat has melted down and the limestone has boiled up, the charge will be benefited by allowing it to "soak" from 15 to 30 min. This will allow any contained slag to rise and also much of the gases. Ore may then be fed if necessary; or, if the heat has come "ready," it remains only to get the steel hot. Sometimes heats will melt low, and if only small ladles are available or there are no heavy castings to pour, it is best to get the heat ready by using manganese. This will not add much metal to the bath, and it is a good substitute for pig-iron.

With large ladles, I would recommend working the heats with both pig-iron and manganese. Very little, if any, ferro-silicon should be used instead of manganese, since the silicon mixes with the slag and cuts the stopper rod off while the heat is being poured. Hot metal is preferable to cold additions, as the bath is not then chilled by the additions.

If the slag comes too quickly and all the additions have to be made to the first part of the heat, an even distribution can be obtained by rabbling the heat. If some of the additions are lost in the slag, or if insufficient has been put in, the heat showing signs of wildness, a simple remedy is to take a number of sticks of aluminium, bend a tapping rod around them, thrust them to the bottom of the ladle, stir the bath with them and rabble it afterwards if necessary. There is hardly a heat that cannot be made absolutely quiet by this means. But it is curative treatment, and a good preventive is always better.

The time consumed in pouring is a factor in determining the size of the heat. Good practice demands that a heat of steel should be poured in less than 60 minutes; the faster the better. The high temperature required to pour steel from 1 to 2 hours causes a great increase in occluded gases and necessitates an increase of about 30 per cent. of ferro-silicon to make it as quiet as when poured at a lower temperature.

The use of fluorspar seems also to make the steel less responsive to the quieting action of silicon, since the fluorine appears to be absorbed by the steel. I have noticed when pouring a test, that after much spar has been used the steel gives off a smoky gas of the same appearance as when fluorspar is added to the bath. If this is true, the action of fluorspar cannot be beneficial to steel when added in large quantities. Good basic steel is harder to make than good acid steel; but if the practice outlined is followed, the steel produced will be as quiet while molten and as solid afterwards as acid open-hearth steel—and tougher.

Silicon Steel for Electric Purposes.

Before the German Foundrymen's Association, recently, Mr. F. Goltze claimed that silicon steel is to be preferred to manganese steel for electrical purposes on account of its superior magnetic properties. Annealing improves the structure and the mechanical properties, and has considerable effect on the magnetic properties, at 750 degs. C. reducing them slightly, and at 1,000 degs. C. establishing a marked improvement, while at 900 degs. C. it has a decidedly adverse influence. Coarseness of grain and good magnetic properties were found to go hand in hand. The addition of aluminium to cast iron was also found to increase the magnetic properties of the iron.

New Design of Regenerators for Open-Hearth Furnaces.*

By H. F. Miller, Jr.

The major cause of the deterioration of the open-hearth furnace as its length of service increases, is the melting down, or rather the slagging, of the chequer-bricks, together with the deposition of dirt in the form of iron oxide, etc., which helps to close the openings, as well as to slag the bricks by chemical action. Any construction that will do away with the necessity of the waste gases coming down through the chequers will eliminate the main reason for their deterioration. There are some other well-defined reasons which are subordinate to the main one given above.

Some of the defects of the present type of regenerator chambers are as follows:—

(1) The chequers cannot be cleaned while the furnace is in operation, nor can they be cleaned at the end of the run without taking out all of the chequer-brick. This causes high costs for labour and bricks. The labour cost is high because all chequer-bricks have to be handled twice. The brick cost is high because many of the bricks are spalled in the double handling, rendering them useless, because a spalled brick will not stand up.

(2) The top courses of brick become coated with iron oxide, etc., melt down, and large amounts of dirt are deposited throughout the chequers, especially at the bottom. The draft of the furnace is decreased by the closing of the top and bottom openings, especially the top ones, and the entire working of the furnace is affected. If an effort is made to clean the chequers, the dirt and bricks falling down into the holes still further diminish the draft.

(3) The distribution of the air or waste gases through the chequers is in many cases uneven, resulting in a lower temperature of pre-heated air and therefore slower working of the furnace. Also, the passage of air and waste gases is so crooked that sometimes the chimney is not powerful enough to overcome the friction.

These items are all important factors in decreasing the possible tonnage of a furnace. The ideal regenerator chambers have then the following qualities to overcome the defects mentioned:—

(1) The chequer-work must at all times be accessible in all parts, so that the chamber can be either cleaned or repaired while the furnace is in operation.

(2) The chamber must be of such shape that the chequers may be cleaned perfectly without touching a brick.

(3) The chequer-work should be so placed that there will be a uniform distribution of air or waste gases throughout the chamber and a minimum of dirt deposited on the bricks nearest the hearth.

(4) The bricks of the chamber should always be in such a state that they would practically never have to be removed.

These qualifications the writer believes would be fulfilled by a regenerator chamber built according to the accompanying design. The explanation of the drawing is as follows:—

The chamber forms an enlarged portion of the flue proper, the travel from the downtake to the chimney being in almost a straight line. The chequers are built on the floor, thus doing away with the unstable tiles and rider walls. The chequers occupy a central portion of the chamber, with an air space at each end as wide as the chamber for a few feet,

* Read before the American Institute of Mining Engineers and published in the "Transactions" of the Institute.

and then converging at an easy angle to the passage-way at each end of the chamber. This air space plays an important part in the life and working of the chequer. The waste gases going out reach this wide distribution space and are slowed up, and the suspended dust is deposited on the floor, from which it may be scraped out at any time through the seals at either side of the distribution space at both ends of the chamber. The waste gases go through the chamber with very little further deposit of dirt. On Saturdays, after the last heat is out, the gas may be put on the end that is to be cleaned and in a short while the temperature of the end of the chamber nearer the air valve will be low enough for a man to enter and clean the chequers with compressed air or steam. The gas chequers are cleaned the same way, except that the gas is not admitted and the manhole is opened to supply air.

The gas sewer in this design of chequers is entirely separate from the flue to the stack and is accessible at all times. In addition to this benefit, the sewer may be burned out quickly with hot air by using compressed air as an aspirator and closing the stack damper from the gas chequers.

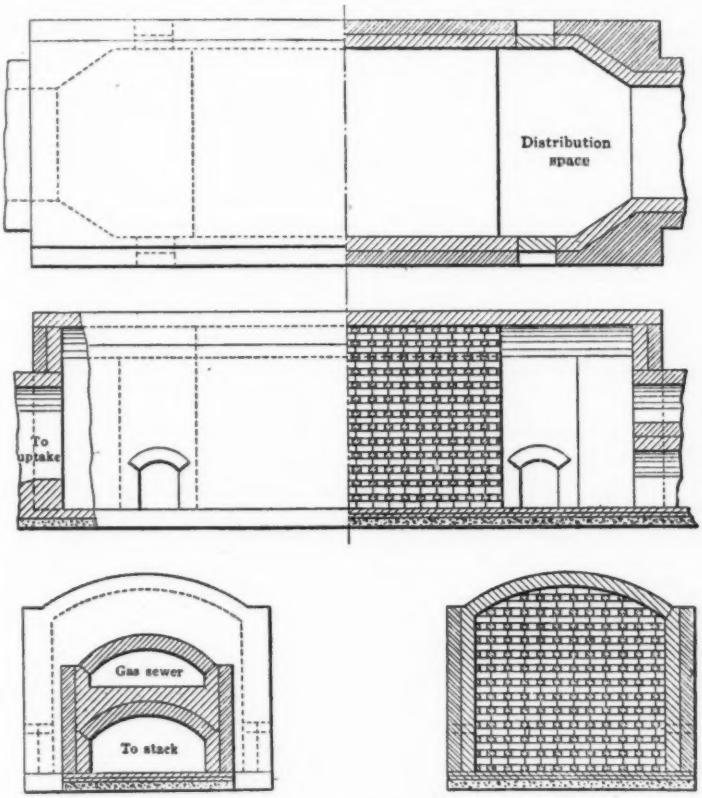
It is readily seen that the chequers will last indefinitely under these conditions, with very few renewals of brick and no renewals of the entire chequers at the end of the run. The wet slag will, of course, be deposited as usual in the cinder pockets.

The results obtained with regenerator chambers built on this design will be as follows :—

(1) There will be no slowing up of the furnace due to loss of draft because of dirty chequers.

(2) The draft will be greater because the lines of draft will be straighter. This is very important in producer-gas work, where the travel of gas should be made as easy as possible. The pre-heated air or gas will be hotter than with the usual chequers because it will be more evenly distributed through the chequers.

(3) The final result, all other things being equal, will be an increased tonnage, a longer run, and faster time made in producing the steel.



NEW DESIGN OF REGENERATOR CHAMBERS FOR OPEN-HEARTH FURNACES.

Mixtures for Metal Patterns.

A good, non-shrinking mixture for metal patterns is often requested, but a non-shrinking metal does not exist. Bismuth, certainly, has only a negligible contraction, as has also antimony; but it is impossible to obtain an absolutely non-shrinking pattern alloy. In making pattern alloys in which the contraction should be reduced as low as possible, the use of bismuth or antimony is advisable, because of their slight shrinkage. Typical pattern-metal mixtures are as follows :—(*a*) Lead, 87 per cent.; antimony, 13 per cent. (*b*) Lead, 80 per cent.; antimony, 10 per cent.; tin, 10 per cent. (*c*) Lead, 80 per cent.; antimony, 15 per cent.; bismuth, 5 per cent.

Small Economies in the Foundry.

By F. H. H.

In competitive trade it behoves every foundry manager to keep a sharp eye to economy, and in the following the writer gives a few details where saving may be effected. These are only economies in materials, as every manager recognises the importance of economy in handling and labour, also economy in production, and the many labour-saving devices introduced during the past few years are eloquent testimony to the attention bestowed on this question. Economy in production varies according to the class of work turned out, and, as a rule, is particular to each shop. In all foundries, however, considerable savings in the materials used are possible.

In aluminium foundries, all cores should be dug out in one particular part of the shop, so that the core sand may be put through a ¼-in. sieve, and taken back into the core shop to be used again. All sprigs and core irons should be sorted out, and thrown into boxes, for many of these can be used again and again, especially in repetition work.

With regard to the wires used in cores, it will often pay to instal a wire-straightening machine. By the aid of one of these machines, a boy could in a few hours straighten sufficient used wires to keep the core shop going for days. Used sprigs should be sorted into boxes, according to size, and used over and over again, whereas many gross find their way on to the rubbish heap in the course of a year.

One of the biggest losses in brass and aluminium foundries is loss of metal in melting. In making brass and gunmetal from their constitutent elements, the zinc should be added not earlier than five minutes before the castings are poured, and preferably after the pot has been drawn from the furnace. The writer has seen a pot of brass left standing in the furnace for twenty minutes after the spelter had been added, immense volumes of zinc fume passing up the flue. In this particular instance, 65 lbs. copper had been melted, and 40 lbs. spelter added. The resulting brass was expected to closely approximate to the ordinary two to one mixture, whereas the castings analysed out at 86 per cent. copper and 14 per cent. zinc, showing that 65 per cent. of the spelter added had been lost.

All foundries suffer loss by spilt or "shot" metal, from careless pouring, and means to avoid this are hard to find, as even the best men are apt occasionally to spill metal whilst pouring. If the spillings and shot are carefully gathered up, it is good policy to run them down in an old pot, some time when a furnace is at liberty. The metal so obtained should be run into ingots, and samples analysed. The ingots can then be used again, taking care to make the alloy up to the required standard.

Aluminium and brass crucibles should be skimmed in separate pits, and on no account mixed. At the end of the day (or the next morning) the skimming pits should be cleaned out, the aluminium skimmings being put in a heap for subsequent remelting, which is best done in the air furnace mentioned later. The brass skimmings can be crushed and washed in a washing plant, and the metal so obtained melted and run into ingots, for analysis and re-use. If a washing plant is not part of the foundry equipment, the skimmings should be looked over, any good metal picked out, and the remainder placed in bags for sale. When the ash-pit of the brass furnaces are cleaned out, the ashes should be carefully sorted over, any partially-burnt cokes picked out and used again, pieces of metal which have spilled over from the crucibles sorted out, and the remainder put in a heap for crushing and washing, or failing that, for sale. If possible, it is better to keep ashes from the brass furnaces separate from the ashes from the aluminium furnaces. Better prices are made by selling the ashes separately than if they are mixed. This is not always practicable, owing to the custom of building a number of furnaces with one pit, and using them for brass or aluminium.

In the same manner, where malleable iron is melted in crucibles, the ashes should be sorted over for partially-burnt cokes and pieces of metal, much of which can be used again. The remaining ashes can then be consigned to the rubbish heap. Malleable iron skimmings should be put in a heap by themselves, as when kept clean they fetch a good price.

When malleable iron castings are drawn from the muffle, any adhering sand should be knocked off, and put through a fine sieve, when it makes excellent parting sand.

The care of crucibles is an important item. They should always be stored in a warm place for at least a week before use, and then it is good practice to stand them on top of the furnace for an hour before actually placing in the fire. A damp crucible will bump or crack if put straight into the furnace, and nothing is so annoying as to lose metal owing to a bad pot.

In an iron foundry, burnt core sand is often thrown away, whereas much of it could be used for "backing sand," after mixing with new sand. A quantity of it can be used each day for making the cupola bed, instead of taking floor sand. Core sand from cylinder castings can now be washed in a special washing machine, and used on cores for an inferior class of work. The dump obtained after dropping the bottom of the cupola should always be sorted over. Any unused coke should be returned to the staging and used in the next blow; iron not melted should be sorted out from the slag, and the remainder thrown on the rubbish heap.

It is good policy to supply proper dusting bags and brushes, as a moulder often takes home on his clothes and hands, more plumbago, French chalk, or flour, as the case may be, than he puts on his day's moulds.

In the fettling shop it is good economy to keep bags or bins for grindings of each class of metal. The grinders should be instructed that before changing over on to another class of material, he should shovel the accumulated metal dust into its proper bin or bag. For instance, a grinder may be on aluminium in the morning, change on to gunmetal for a couple of hours in the afternoon, and finish the day on common iron. It is only a few minutes work to gather up the metal dust. All grindings kept free from contaminating material have a market value, but dealers are not at all anxious to buy

mixed dust. If the grinding wheels are fitted with exhaust hoods, the problem may not be so easy, but it is usually possible, with a little ingenuity.

The sand which accumulates on the fitting shop floor should be periodically swept up, put through a fine sieve, and much of it used again. Sprigs and core irons must be sorted out, also metal chippings. If large quantities of aluminium castings are made, the value of the chippings represent a considerable sum in the course of a twelvemonth. The most economical method of dealing with these is to remelt them in an air furnace of the reverberatory type. One of these furnaces is essential if aluminium turnings from the machine shop have to be dealt with. It is absolutely impossible to melt aluminium turnings in crucibles, apart from the cost being prohibitive. A small furnace holding from 1 to 1½ cwts. of aluminium per charge, costs approximately 2s. per cwt. for labour and material, melting turnings. It is advisable to first charge about 20 lbs. chippings or skimmings into the furnace and obtain this in a molten condition before any turnings are added, otherwise the latter are apt to clog at the bottom of the hearth, and "tapping out" becomes difficult. The metal should be run into ingots, and samples analysed. There are usually a number of jobs in the foundry for which about 10 per cent. remelted turnings in a new alloy will have no bad effects, care being taken that extra copper and zinc are added to make the alloy to the required constitution. Remelted turnings always lose in melting a small proportion of copper, and somewhere about half the total zinc.

If malleable iron is cast, many small economies are possible in annealing. In the first place, good coal is most necessary, and trials of various brands should be made, until the most economical is found. Annealing ovens have certain personal peculiarities, depending on the arrangement and size of the outlets, position of the flue, diameter and height of stack, etc., and have to be humoured accordingly. The writer found from a study of many kinds of coal, that the ash varies from 5 per cent. to 40 per cent. It is obvious that the lower the percentage of ash the more economical is the coal, other things being equal. The best coal for annealing purposes rarely contains more than 7 per cent. ash. By attention to this point, in one case where 10 tons were being annealed per week, a saving of about £55 per annum was effected.

Wherever large stocks of coal are stored, quantities of small coal and slack accumulate, especially if the coal is carted to the works and "tipped." The small coal can always be used in the muffle furnace, and for lighting the pot furnaces and cupola. If there is a steam boiler in connection with the foundry the slack can be used up on this. If not, it is best to stack it in a heap and sell it; usually a shilling or two per ton can be obtained for it. If plenty of yard room is available, it is good policy to keep two stacks of coal going. One can then be used up, the small coal and slack cleared away, and further deliveries of coal tipped there while the second stack is being used. This prevents having a large accumulation of "smalls" at any one time.

Scalings from annealing pans, also worn-out pans, are saleable articles, and may amount to a respectable figure in the course of the year, where large quantities of work are being turned out.

Ashes can often be disposed of free to builders, who will cart them away from the works; a saving to the foundry of the cost of carting and the charge for the "tip."

The items mentioned are not, by any manner of means, all the economies possible in a foundry, but the writer hopes they will show the necessity for wide-awake management.

Remelting Iron Turnings and Chips.

In a recent issue of "Giesserei Zeitung" is described an interesting method of remelting iron turnings and chips by injecting them under pressure into the melting zone, thereby making briquetting unnecessary. The usual method of successfully disposing of practicable quantities of iron turnings or chips is in the form of briquettes which are added to the regular charge in cupola. By this new method, however, the turnings can be used in their natural state without previously briquetting them.

The loose turnings are injected under pressure into the melting zone of the cupola (see Fig. 1). To accomplish this the inventor makes use of apparatus by means of which, besides the usual charge of about 1,000 kg., from 5 to 20 per cent. of iron turnings can be injected into the cupola without, it is claimed, increasing the coke consumption. The operation and conduct of the furnace is normal and the waste is small, as has been established by experiments extending over several months. It is said not to exceed that which occurs in the use of briquettes.

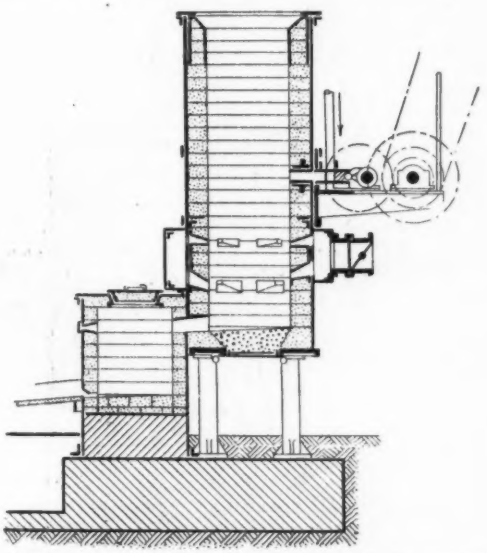


FIG. 1.—CROSS-SECTION OF CUPOLA AND INJECTION APPARATUS.

The apparatus for injecting the chips or turnings of iron is shown in cross-section. It consists essentially of two cylinders situated close together, in which a piston is made to move back and forth by means of a crankshaft or an eccentric. The propulsion of the machine is accomplished by means of a connecting gear or a suitable motor. In order to render the movement of the machine free from shock, a small balance wheel is connected to the crankshaft near the motor. Further, in order to be able to inject the desired percentage of turnings, the propelling mechanism is regulated by means of two speed pulleys which hasten or retard the rate of the machine at will. By regulating these speed pulleys, 5, 10, 15 or 20 per cent. or more of iron turnings can be injected into the melting zone.

A foundry in Berlin is stated to have installed this apparatus and by means of it will shortly attempt to turn to account its large amount of waste iron.

The "Rennerfelt" Electric Furnace.

As will be seen from the annexed sectional views Fig. 1 and 2, the "Rennerfelt" electric furnace is constructed on much the same lines as the "Stassano" furnace, the chief difference between the two types lying in the arc field, which in the "Rennerfelt" furnace is vertical, one of the three electrodes used being fixed in a vertical position. A further feature is that the points of the two horizontal electrodes can be moved in a vertical direction, the idea being to provide facilities for varying the height of the arc according to the level of the charge. In the case of charges being made which cause shrinking, as, for instance, scrap or iron sponge, it is obvious that this feature will be of advantage.

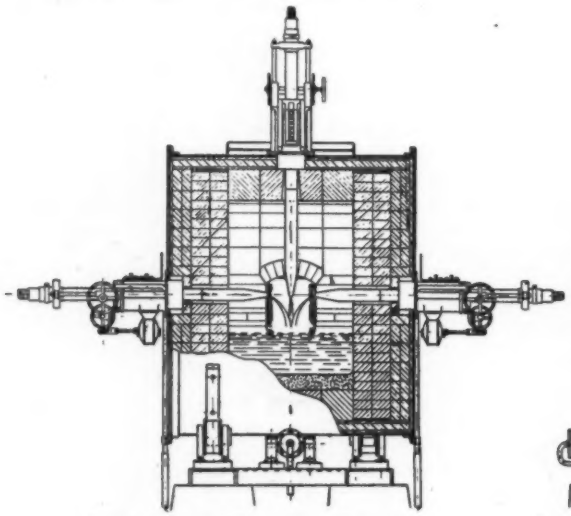


FIG. 1.—FRONT SECTIONAL ELEVATION.

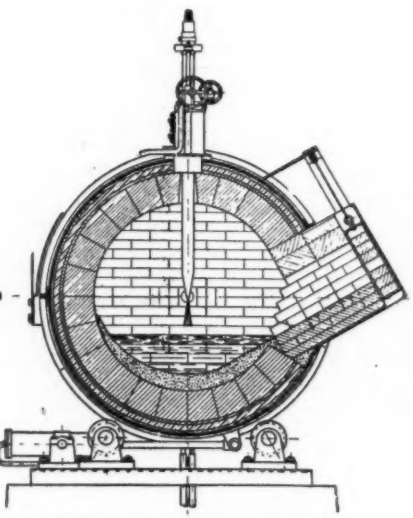


FIG. 2.—SIDE SECTIONAL ELEVATION.

THE "RENNERFELT" ELECTRIC FURNACE.

A furnace of this type was constructed and put into operation at the Hallstahammer Iron Works in Sweden last year, the results being such that it has now been decided to erect a steel foundry equipped with two furnaces of 1,000 kilos capacity, and one of 200 kilos. The furnace already installed can take charges up to 200 kilos, and was designed for a consumption of energy of 90 to 100 h.p. It is in the form of a cylinder with a horizontal main axle. The ends are flat and act as the supports of the electrode holders, which serve also as cooling boxes. The third electrode is introduced vertically on to the other two through the top of the furnace. With a view to facilitating the insertion of the internal brickwork, the framework of the furnace has been constructed in upper and lower halves. The furnace is placed on roller bearings, which facilitate tilting and the tapping of the slag and steel.

As already mentioned, the two side electrodes can be adjusted in a vertical direction, which is a great advantage, as thereby a minimum distance between the charge and the arcs can be maintained, the charge being thus exposed to a more intensive heat than the arched roof, the durability of which is thus increased. In working it is often desirable to force up the temperature, especially for removing the sulphur, and it is obvious that if an increased amount of energy can be employed without the danger of overheating the roof, the life of the furnace will be prolonged; in addition, time will be gained, as the smelting process will not last so long. The roofs of electric furnaces being generally one of their weakest points, the semi-circular form has been chosen in the design under notice in order to keep the distance between the charge and the roof as great as possible, and thus prevent overheating. Low roofs have the great drawback, as against high roofs, that silica bricks must be used, which melt at 1,830 deg. C., or at a much lower temperature than the magnesite bricks which have been employed in this furnace. It is, indeed, more than doubtful whether silica bricks should be employed at all in electric furnaces, as they are injuriously affected by the basic vapours of calcium and iron, whereby silicates of iron and calcium are formed, which may also affect the bath.

The electrodes used are made from electro-graphite and possess a much greater capacity as conductors than ordinary carbon electrodes. As a result they can be made of smaller dimensions, which is an advantage in the case of electrodes introduced through the roof of the furnace, in that the roof is not unduly weakened. The graphite electrodes employed have a diameter of only 32 millimetres (1.28 in.) and their resisting capacity has been demonstrated up to a load of 70 amperes per square centimetre. As regards energy, any kind can be employed for this furnace, direct or alternating-current, the number of periods of the latter being of no consequence. As to pressure, 100 to 110 volts may be regarded as most suitable, although 50 to 60 volts may be used.

Experience has shown it to be more advantageous in many respects to employ electric arcs

freely burning than arcs constantly in contact with the charge; especially is this the case in small furnaces for the manufacture of electric steel from scrap iron. With freely-burning arcs there is less risk of the contact being interrupted, and the current is subjected to fewer fluctuations with their disturbing consequences. A further advantage with freely-burning arcs is that the surface of the bath can be more easily kept covered by a layer of slag. The reaction is thereby furthered, and any risk of burning the charge is avoided. In furnaces of the ordinary type usually a space free of slag forms just below the electrodes, where the arcs come into contact with the bath, and there is therefore nothing to prevent particles from the points of the electrodes dropping into and be mixed with the charge, which may cause great disturbances.

The chief advantages claimed for the "Rennerfelt" furnaces may be summarised as follows:—

(1) It possesses a high thermo-electric efficiency, due in part to the manner in which the heat is produced and in part to the construction of the melting chamber and arrangement of the electrodes, which allows of the furnace being tightly closed.

(2) Any system of energy can be used, and in the case of alternating current the number of periods is immaterial.

(3) The construction of the melting chamber and arched roof renders them strong and durable, and the loss of heat by radiation is reduced to a minimum.

(4) The arrangement for regulating the energy is very simple. In case of polyphase current being used, only two of the three arcs require regulation.

(5) The arcs are independent of the charge, which facilitates smooth and quiet working.

(6) The height of the arcs above the charge can be regulated without affecting the consumption of energy

(7) The arched roof of the furnace is not weakened by a number of large electrodes, there being only a single one of a relatively small diameter passing through it.

(8) If required, the working of the furnace by the aid of freely-burning arcs can be altered during the process to the system of working by arcs combined with the charge.

(9) Magnesite bricks can with advantage be employed in the construction of the arched roof, allowing the use of a very high temperature.

(10) Owing to the position and small size of the electrodes the admission of air currents can be avoided.

(11) The form of the arcs and their position in relation to the charge assist the reaction.

(12) The heat is distributed in the most effective manner over the whole surface of the charge, partly direct and partly by radiation from the roof.

(13) The phase-displacement is very small.

At the present time there are eight "Rennerfelt" furnaces at work or under construction. Apart from the one at Hallstahammer, there are as yet no working results available. This is lined with Austrian magnesite bricks at the ends as well as in the roof, and it is also carefully isolated by the aid of firebricks and asbestos. Austrian magnesite is especially free of quartz and oxide of iron, which makes the bricks very refractory with comparatively small shrinkage. The furnace has dealt with 102 charges without any repairs having been necessary except the ordinary ones to the bottom of the melting chamber. It has been worked for more than seven weeks for an average of 12 hours per day, and while no smelting was going on it was kept warm by a consumption of energy corresponding to from 15 to 35 per cent. of the normal consumption. The brickwork was thus subjected to rather extreme changes of temperature, in view of which the results are the more satisfactory.

As regards the important item of the consumption of electrodes, the average figure during an observation period of 36 hours was 0.128 kilo of electrodes per hour, while it amounted to 0.183 kilo per hour during another period of 24 hours, when electrodes of a diameter of 38 mm. were used instead of 32 mm. For the smelting of 120 kilos of mild scrap 75 minutes were required with a consumption of electrodes of 1.25 kilos. If the refining period be estimated to be the same, the consumption will thus amount to 2.5 kilos per ton of finished steel, which must be regarded as satisfactory. The average consumption of energy was about 590 kw.-hours per ton of steel, which could be reduced by the employment of larger furnaces.

The Bunsen Burner for Drying Ladles.

The application of the bunsen burner to the drying of foundry ladles is discussed by Mr. O. Johannsen in a recent issue of "Stahl und Eisen." In some present methods of drying ladles the admission of the flame and the mixing of the necessary air for combustion often present difficulties. The gas burns with a flickering cold flame and often only in the upper part, so that the bottom of the ladle which needs the most heat receives the least. The simplest arrangement for the intimate mixture of gas and air is the bunsen burner. The adaptation which Mr. Johannsen especially recommends for ladle drying is

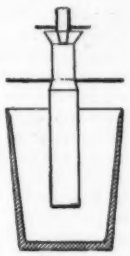


FIG. 1.

shown in Fig. 1. It is an inverted bunsen burner which burns in the interior of the ladle. In order to cause the flame to burn as far as possible on the walls of the ladle and not ascend the middle, a shield is provided. This prevents also the drawing of the prdoucts of combustion into the burner mixing pipe. The end of the burner is covered with wire netting of 4 mm. mesh, and the long narrow design makes possible a rapid delivery of gas and a high temperature. Producer gas, blast-furnace gas, or waste gas from the furnaces can be used. Ladles are said to dry very quickly with the use of this burner.

Acid-Proof Metal.

A contemporary gives the following as a mixture to be used for casting pipes to be laid in a solution of hydrochloric acid and water:—Copper, 85 lbs.; tin, 8 lbs.; phosphor tin, 2 lbs.; and lead, 5 lbs. The pipes in question were for conveying steam or hot water for heating the acid solution when pickling.

D

Correspondence.

Blast Quantity and Pressure in Cupola Working.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In answering Mr. Liardet's first letter, I purposely left the shape of the tuyeres out of the question, as I considered his attack on the method of air measurement of the most importance. The particulars that he is anxious to have are:—

The inside lining of the cupolas is parallel from the charging doors down to the hearth; the tuyeres are square at the cupola casing, changing to oblong and converging slightly towards the interior of the cupolas. The number and total area of them is given in the Paper.

His remarks on the calibration of his orifices for measuring the air flow are interesting, and I am quite willing to believe that he made every effort to obtain accuracy, but as he does not give particulars of the proportions of his apparatus, nor the formulæ he deduced from his experiments, he still leaves us in the dark as to the reason of the discrepancy between his results and mine.

The fact that Mr. Liardet regards air pressure in a cupola as a necessary evil, is no reason why it should be ignored in calculations affecting cupola working. The research was started under the belief that the volume of air was the only important factor, but I soon found that the same quantity of air, with varying pressure, due to difference in packing the cupola, gave varying results in the amount of metal melted. As Mr. Liardet agrees that a certain velocity of air is necessary for good working, may I remind him that this is just what the Paper claims should be taken into account, pressure all through being converted into velocity, velocity being, by the theory of the flow of air through orifices, approximately proportional to $\sqrt{P}$.

It is, of course, impossible to alter the blast pressure as distinct from quantity without altering either the tuyeres, or burden in the cupola, and this point is sufficiently answered by the foregoing remarks.

Mr. Liardet agrees that a certain quantity of oxygen is necessary for proper combustion, and then states that the air should be measured in cubic feet. Now the oxygen content in a cubic foot of air will vary from day to day within wide limits, according to its density, due to temperature and atmospheric pressure, whilst the oxygen in a lb. of air is constant, as the above variations are considered in the calculation, therefore on his own reasoning of the oxygen content, calculating by weight is the more preferable and accurate method. His further suggestion that air should be considered in cubic feet because blower makers catalogue and sell blowing machinery under this form of specification is quaint, but not convincing.

The tests published by Mr. Liardet are interesting, covering as they do many different size cupolas. The output stated for the 27 in. cupola agrees exactly with the maximum I obtained on the cupola of the same size, although we were led to believe by Mr. Liardet's first letter that he always obtained a larger output than that given in my results. I suggest that the fact that his cupola requires so much more air to give a similar output of metal than does the one I experimented on, is well worth his firm's attention, especially as the work done on the same subject by Professor John Jermain Porter in America afford some proof of the accuracy of my results of the quantity of air required.

Yours, etc.,

F. J. COOK.

Birmingham,
October 27, 1913.

F.T.J. Bookshelf.

Transactions of the American Institute of Metals, Vol. VI.

Edited by W. M. Corse, Secretary. Published by the Institute, Buffalo, New York, U.S.A.

This volume of the "Transactions" of the American Institute of Metals deals with the Sixth Annual Meeting held at Buffalo, September 23 to 27, 1912. The report of the official chemists of the Institute, with the discussion on the report, occupy 43 pages; and this is followed by an interesting survey, by Mr. G. Shaw Scott, M.Sc., of the history and achievements of the British Institute of Metals. The work of the American Bureau of Mines relating to non-ferrous metals is next discussed by Dr. C. L. Parsons, and then follow a number of Papers presented before the Buffalo meeting, the subjects including the structure of galvanised iron, the electric furnace in non-ferrous work, boronised copper, the thermal diagram of the bronzes, test-bars for non-ferrous alloys, influence of pouring temperature on manganese bronze, the casting of German silver, core flours, and other matters of interest to non-ferrous metal workers. Since the Institute (formerly the American Brass Founders' Association) treats very largely with cast metals, this volume of "transactions" should appeal strongly to the foundryman.

"The Mechanical World" Pocket Diary and Year Book for 1914.

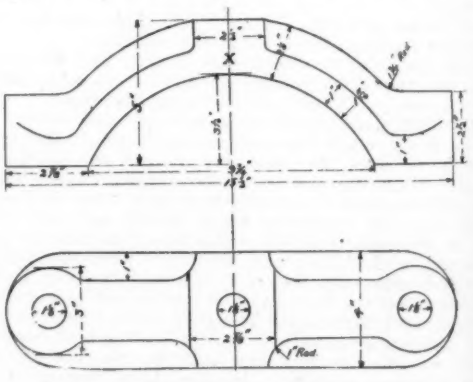
Published by Emmott & Company, Limited, 65, King Street, Manchester.

This useful little annual is now in its 27th year of issue. While it follows the same lines as previous editions, it has experienced considerable revision and the addition of new features. The section on steam turbines has been partly re-written, and new data and illustrations introduced. A lengthy section on milling and gear-cutting on the milling machine is now included, and also a section on grinding and numerous other data.

Query.

Castings to Stand Pressure.

Herewith is a sketch of a clip casting, on which I should be very pleased to have the views of some expert foundryman regarding the best way to run



it, and what mixture of iron to use. The trouble has been to get them to hold in high-pressure gas at the section marked X.

"T. B."

Inventions.

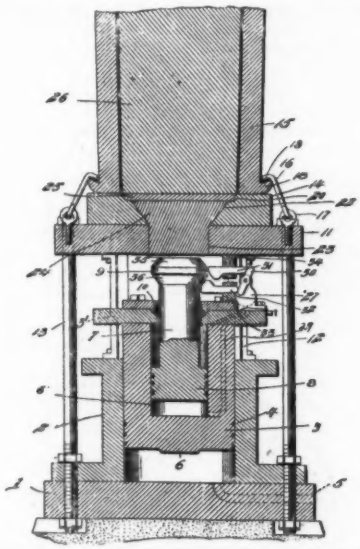
Applications for Patents.

An Asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

21,158. Metal-melting furnaces. I. Hall.
21,161. High-temperature furnaces. A. A. Govan.
21,194.*Moulding-machines. (W. Caspary, Germany).
21,327. Regenerative furnaces for the treatment of steel. J. S. Atkinson.
21,405. Machine tool for cutting steel. W. Waring.
22,159.*Induction furnaces. Albert Hiorth.
22,263. Manufacture of semi-steel. W. Muirhead.
22,310. Melting metals and heating furnaces by high-pressure gas. A. P. Townsend.
22,388 & 22,389. Casting metals. W. F. Sollis and J. Lambert.
22,479. Apparatus for casting metals. C. W. Seymour.
22,585.*Regenerative furnaces. H. Rehmann and H. Bangert.
22,657. Furnaces for melting metals. T. Ratcliff and W. Ratcliff.
22,692.*Manufacture of pig-iron. C. A. Keller.
22,706.*Metal-working machines with work-holding magnets. Magnet-Werk G. M. B. H.
22,723 and 22,724.*Electric furnaces. E. Stassano.
22,731. Recovery of volatilised metals from furnace fumes. (B. Howe, West Australia.)
22,763.*Process of and apparatus for charging furnaces. W. Puschmann.
22,834.*Producing and refining metals. S. B. Frumkin.
22,840. Liquid hydrocarbon furnace for heating, roasting, refining, smelting, etc. D. de Ros.
22,874.*Utilisation of the heat of slag. C. Semmler.
22,875.*Utilisation of waste heat in the manufacture of iron. C. Semmler.
22,923.*Autogenous welding and cutting of metal. M. Kongsbak.
22,929.*Circular saw blades for cutting metals cold. A. Rocour.
23,004.*Smelting metal, metal ores, etc. S. Guggenheim.
23,319.*Draft burners for welding and cutting metals. A. Baechtold-Strobel and T. Cartier.
23,493. Stirring or agitating molten metal in melting-pots. I. Hall.
23,521. Metal-melting apparatus. W. I. Burch.
23,611. Process for the production of steel. D. Colville.
23,612. Process for the production of nickel steel. D. Colville.
23,622.*Manufacture of steel. (H. Martin, France.)

Abstracts of British Patent Specifications recently Accepted.

412 (1913). *Process of Casting.* The Liquid Forged Steel Company, 1,216, Citizens Building, Cleveland, Ohio, U.S.A.—The annexed cut is a vertical central longitudinal sectional view of one form of apparatus adapted for use in practising the invention. 1 designates any suitable base or bed, from which rises a cylinder 2 having open top through which works a piston 3 suitably packed as at 4. Water or other fluid under pressure, is admitted into the bottom portion of cylinder 2, through a suitable port 5 formed through the base or bed 1. The bottom of the piston 3 is provided with a central depending boss 6 designed to strike the base or bed 1 so as to support the bottom of the piston slightly above the base or bed 1, thereby to provide a space to receive water initially introduced into the cylinder. It will, of course, be understood, that the exhaust from the cylinder 2 may pass out through port 5. The piston 3 is hollow; that is to say, it is provided with a central longitudinal bore 6¹ opening through the top of the piston. Working in this bore of the piston 3 is a plunger including a stem or shank 7 of somewhat less diameter than that of the bore of the piston. This shank is provided at its lower end with a piston head 8, suitably packed and working in the cylinder formed by the hollow piston 3. At the upper end of the stem 7 there is a striking head 9 designed to apply impacts to the ingot. The top of the cylinder 3 is provided with a suitable gland 10, through which piston shank or stem 7 works. For the purpose of supporting the ingot above the striking head 9 there is provided a table or platform 11, supported by standards 12 rising from the top of the fixed or stationary cylinder 2. Suitable bolts or rods 13 extend between the base or bed 1 and the table 11. Upon the table 11 is a casting plate 14. The ingot mould 15 rests upon the casting plate 14, and is held down against the plate by suitable fastenings. These fastenings consist of hooks 16 hinged or loosely connected to the table 11 by means of eyes 17, each hook being designed to engage with a suitable ear or lug 18 upon the ingot mould. In order to insure a proper engagement between each hook and adjacent lug, a wedge 19 is driven in between the hook and the ear. By the means described a mould may be very conveniently and rigidly held against the casting plate so as to avoid displacement by the blows imparted by the striking head 9 over plunger 7. In the top of the casting plate 14 is a central depression or seat 20 of suitable shape corresponding to the cross-sectional shape of the lower end of the ingot. A downwardly



Casting Apparatus, by the Liquid Forged Steel Company.

tapered opening 22 extends from the seat or socket 20 with its open lower end registering with an opening 23 extending through the table 11 in alignment with the striking head 9. Working in the openings 22 and 23 is an impacting and stripping head 24, the lower end of which is in the path of the striking head 9. A suitable plate 25 rests loosely in the seat 20 so as to be interposed directly between the impacting and stripping head 24 and the ingot 26 in the mold. For the automatic control of the percussive piston 7 there is provided a valve chest 27 carried by cylinder 3, there being upper and lower ports 28 and 29 establishing communication between the valve chest 27 and the bore of the cylinder 3. The valve chest 27 is controlled by suitable tappet mechanism, including a rocker arm 30 and upper and lower reciprocating tappet elements 31 and 32, arranged to co-operate with the striking head 9 and rocker arm 30. The lower tappet member is mounted in a suitable guide 33 secured to the top of the adjustable cylinder 3, while the upper tappet member works in a guide 34 carried by the table 11. The striking head 9 of the percussive piston is provided with upper and lower bevelled portions 35 and 36, co-operating with the respective tappet elements 31 and 32, to slide the same back and forth and thereby throw the rocker arm 30 to shift the valve in the valve chest 27. For the purpose of

guiding the adjustable cylinder 3, the head of that cylinder is provided at its outer edge with notches or recesses 3^1, each of which receives one of the standards 12, whereby the cylinder 3 is guided in a true vertical direction in its up and down movements.

21,019 (1912). *Foundry Moulding Machines.* W. D. Oddy, Mill Street, Meadow Lane, Leeds; and H. Richmond & Sons, Limited, Donisthorpe Street, Hunslet, Leeds.—Fig. 1 is a plan view, partly diagrammatic, of a foundry moulding machine constructed according to the invention; the left side of Fig. 2 is a vertical radial section through the one of the presses, *e.g.*, one line A, O, of Fig. 1. The right side of Fig. 2 is a vertical radial section on line O, B, of Fig. 1 showing the bottom pattern plate in its lowest position, and for the sake of convenience, also the gearing for intermittently rotating the table. *a* is the intermittently rotated table, carried by a short cylinder *b* connected to the fixed central pillar *c*. *d* indicates three rectangular openings symmetrically arranged in the table *a*. *e* are the bottom pattern plates, which fit in the openings *d*, and are supported by antifriction rollers *f* on the circular track *g*. In the stationary positions beneath the presses they are supported by broad lugs *h*, resting on pedestals *i* carried by any convenient part of the frame of the machine. *j* are the flasks or moulding boxes, which are

FIG. 1.

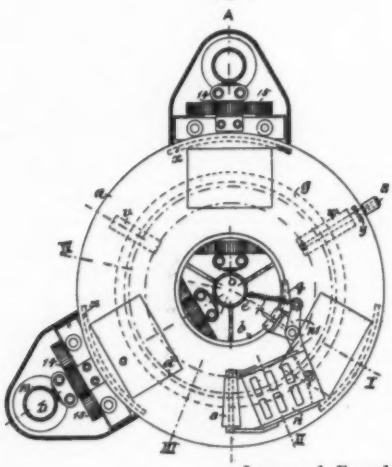
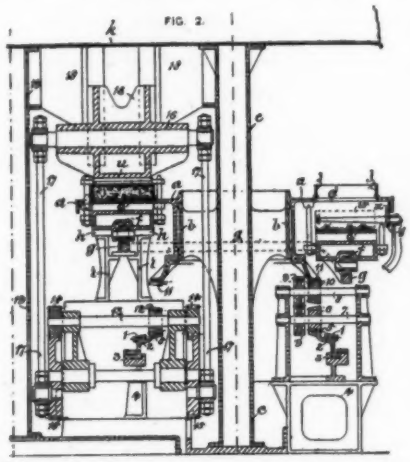


FIG. 2.



Improved Foundry Moulding Machine.

placed on the table, so as to enclose the openings *d*, when the latter are about the position indicated by I, Fig. 1. *k* is a circular or annular trough containing the supply of moulding sand, and shoots or hoppers are suspended from the same at the positions marked II. and IV. in Fig. 1. The lower ends of the hoppers are provided with means for automatically supplying sand to and spreading it over the mould boxes and bottom pattern plates, as they pass beneath the lower ends of the shoots or hoppers. *n* is a deep-slotted plate or grid, fitted capable of being reciprocated between two fixed slotted plates forming the bottom of the hopper. The reciprocation of the grid is effected in the one direction by means of a lever n^1 carried from the cylinder *b*, one arm of the lever being moved by the cam *q* carried from the revolving table by a bracket, as the arm passes over it. The return movement is caused by the spring *r*. The sand is subjected to a preliminary consolidation by means of a roller *s* carried in slot bearings, which rides up the lip on the forward edge of the mould box, and then drops on to the sand in the mould box as the latter passes under the roller. The sand immediately over the pattern plate is thus partially consolidated before the mould box reaches the first press. The table remains stationary whilst the pressing block is lowered and raised. Where the mould box is relatively deep, a second shoot or hopper and supplying device may be carried from the sand trough about the position indicated by III. After leaving this so-called first press, the mould box is carried under a second or third sand supplying hopper, as the case may be, situated at the part indicated by IV., where the box is completely filled, and after passing beneath a plain roller or levelling scraper, the box comes to rest beneath the second press, A. O. being the centre line of this press. The mechanism for intermittently rotating the table has the full and mutilated circles of teeth on the same side instead of on opposite sides of the intermediate wheel; and consists of a first driving shaft situated radially at any convenient position beneath the table, and provided at its inner end with a bevel pinion gearing with the outer ring of teeth 1 Fig. 2, on the circular casting 2, the latter being carried by a circular race 3 supported on pedestals 4, and concentric with the table *a* and central pillar *c*. The casting carries an inner curved row or mutilated circle of teeth 5, which extends over three-sevenths of the circumference. For example, the curved row of teeth contains, say, 54 teeth, whilst the complete circle would contain 126 teeth. A pinion 6, having 18 teeth, mounted on the countershaft 7, gears with the curved row of teeth 5, so that the countershaft 7 makes three revolutions during three-sevenths of the revolutions of the wheel or casting 2, and remains stationary during four-sevenths of such revolution. A second countershaft 8 is geared by equal sized wheels 9 with the countershaft 7, and carries a bevel pinion 10 provided with 14 teeth, which gears with the bevel wheel 11 attached to the circular boss of the table *a*. The countershaft 8 like the countershaft 7 makes three revolutions for each complete rotation of the mutilated gear wheel 5, and moves the table *a* by the pitch of 42 teeth, that is, one-third of a complete revolution of the table. The table *a* thus makes a complete revolution for three complete revolutions of the mutilated wheel 5, in three successive movements, separated by stationary intervals; the time of movement being to the times of the stationary intervals as three to four. The movement of each press is imparted from the mutilated wheel 5 by means of a pinion 12 having 18 teeth mounted on a countershaft 13 provided with pinions 14 having 20 teeth, gearing with the wheels 15 having 60 teeth; the wheels 15 serving as the crank discs. The sliding cross-head 16 of the press is connected by side rods 17 to the crank pins of the crank discs 15, and is guided by guides formed on the cross or bridge piece 18, connecting the outer and central pillars 19 and *c*. The press crosshead thus makes a down-and-up movement each time the teeth of the mutilated wheel passes under the pinion 12, that is, during each of three separate sevenths of a complete rotation of the table *a*.

Trade Talk.

MR. JOHN GILL, Queen's Foundry, Saw Yard, Wakefield, has been adjudged bankrupt.

THE ASTER ENGINEERING COMPANY, LIMITED, is being wound up voluntarily with Mr. A. Dobson, of Wembley, as liquidator.

THE COVENTRY ORDNANCE WORKS, LIMITED, have removed their London offices to 3, Central Buildings, Westminster, S.W.

THE London offices of Cammell, Laird & Company, Limited, have been removed to 3, Central Buildings, Westminster, S.W.

A SITE has been secured on the Trafford Park Estate, Manchester, by the Kenyon Ironworks Company, Limited, for new works.

CARBIC, LIMITED, engineers, late of 27, Cannon Street, London, E.C., have removed to Walworth House, 51, Holborn Viaduct, London, E.C.

THE ASSOCIATED MANUFACTURERS' COMPANY, engineers, have removed from Kentish Town, N.W., to 72 and 80, Mansell Street, Aldgate, London, E.

FIRE broke out last month in the Grangemouth yard of the Greenock and Grangemouth Dockyard Company, Limited, and considerable damage was caused.

MESSRS. ISAAC GUEST & SON, engineers, of the Hanbury Works, Brettell Lane, Stourbridge, have transferred their business to the Dial Foundry.

A BLAST-FURNACE at the Solway Ironworks, Maryport, owned by the Workington Iron and Steel Company, Limited, was damped down on October 25.

MESSRS. J. T. WILLIAMS & SONS, engineers and iron, metal and machinery merchants, have removed their city offices to 37, Queen Victoria Street, London, E.C.

THE AFRICAN STEEL SYNDICATE, LIMITED, is being voluntarily wound up, with Mr. A. D. Owen, of Threadneedle House, 34, Bishopsgate, London, E.C., as liquidator.

MESSRS. A. G. GRAZIANI & COMPANY, British and Colonial agents for the F.I.A.T. oil-engine, have removed to 109, Victoria Street, Westminster, London, S.W.

THE offices of Watts Bros. (Sheffield), Limited, engineers, have been removed from Cambridge Street and Wellington Street, Sheffield, to the Triumph Works, Sheffield.

BI-METALS, LIMITED, late of 80A, Southwark Street, London, S.E., have removed to larger and more commodious premises at 57, Lant Street, Southwark, London, S.E.

By an outbreak of fire on October 21 in the premises of Messrs. John Dalgleish & Sons, Avenue Iron Works, Coggan Street, Pollokshaws, Glasgow, considerable damage was done.

THE shareholders of the Nevile Engineering Company, Limited, have decided to wind up the company voluntarily. Mr. G. W. Bull, 9, Foregate Street, Worcester, has been appointed liquidator.

MESSRS. C. W. OWLES and J. T. CUMMING, carrying on business as engineers and smiths, at 59, Macks Road, Bermondsey, London, under the style of Owles and Cumming, have dissolved partnership.

AT a conference of manufacturers held at the National Gas Exhibition, presided over by Lord Weardale, on October 29, Professor W. A. Bone (London) read a paper on "The Industrial Use of Coal Gas."

MESSRS. H. W. BUTLER & COMPANY, Craven House, Kingsway, London, W.C., have been appointed British agents of the Ateliers de Constructions Electriques, du Nord et de l'Est, of Jeumont (Nord), France.

MANNING, WARDLE & COMPANY, LIMITED, Boyne Engine Works, Hunslet, Leeds, have appointed Messrs. Scrivener, Breffit & Company, 34, Park Place, Cardiff, to be their agents for the sale of locomotives, etc., in South Wales.

SIR H. F. DONALDSON presided at the opening of the winter session of the Institution of Mechanical Engineers, when Mr. R. B. Creak, of Manchester, contributed a paper on "Modern Flour Milling Machinery."

MESSRS. PYNE, HUGHMAN & COMPANY, engineers, Calcutta, India, have established a branch at Bank Chambers, 329, High Holborn, London, W.C., which will be under the charge of Mr. F. M. Short as European manager.

THE steamer now on the stocks in the Londonderry Shipyard, and which is to be named the "San Francisco," is officially announced to have been purchased by the United States Steel Corporation for the Pacific and European service.

THE business of Mr. William Ure, Ayr Foundry, Green Street, Ayr, carried on by Mr. James Dawson Ure, has been transferred to Mr. Andrew Hunter and Mr. James Hunter, who will carry on the business under the firm of A. and J. Hunter.

MR. C. W. ROBINSON, trading as C. W. Robinson & Company, Forth Bridge Steel Works, Polmont, has suspended payment, and has granted a trust deed on behalf of his creditors in favour of Mr. John Duncan, jun., C.A., 226, St. Vincent Street, Glasgow.

EXTENSIVE improvements have been carried out at the Vulcan Mills, Bridge Street West, and Hospital Street, Birmingham, of Messrs. Dugard Bros., brassfounders, metal rollers, and brass and copper wire manufacturers, including the erection of a new casting shop.

MESSRS. DOHERTY & BAMBER, engineers and merchants, of 25, Victoria Street, Westminster, London, S.W., have been appointed sole British agents for the sale of railway carriages and wagons, etc., as manufactured by La S.A. les Ateliers du Roeulx, Le Roeulx, Belgium.

RALPH MARTINDALE & COMPANY, LIMITED, edge tool manufacturers, of the Crocodile Works, Alma Street, Aston, Birmingham, and Sheffield, are concentrating the whole of their business at the Birmingham works, which have been considerably enlarged and improved in consequence of the change.

AN Electrical Exhibition promoted by the Electricity Department of Glasgow Corporation has been formally opened, under the presidency of Lord Provost D. M. Stevenson, and will be continued until November 15. The Exhibition embraces electrical machinery and appliances of every description.

A PETITION presented to the High Court of Justice for confirming the proposed reduction of the capital of Martin, Earle & Company, Limited, from £245,000 to £146,000, by cancelling capital which has been lost or is unrepresented by available assets, will be heard before Mr. Justice Astbury, on Friday, November 7.

NEW works have been built in Aston Brook Street, Birmingham, for Messrs. F. & T. Prime, ironfounders, Alma Street, Birmingham, who propose concentrating the whole of their business at the new establishment. A large area of ground has been taken in Aston Brook Street, which will be available for extensions when required.

A LECTURE on the life of Sir Henry Bessemer has been delivered to the members of the Wolverhampton and District Engineering Society by Professor Thomas Turner, M.Sc., A.R.S.M., F.I.C. The subject was chosen on account of the centenary of the birth of the great inventor falling this year. Mr. J. Thompson took the chair.

THE co-partnership of Stevenson & Binnie, engineers, millwrights and ironfounders, Rosehall, Haddington, of which Mr. David Stevenson and Mr. Mark Binnie were the sole partners, has been dissolved by the retirement of the latter. Mr. Stevenson has taken over the business, and will continue the same in his own name and discharge the liabilities.

JAMES KEITH & BLACKMAN COMPANY, LIMITED, of Arbroath, have placed contracts for additional extensions to provide machine and erection accommodation. Quite recently the firm carried out a large extension of their

works between Lordburn and Gravesend, but the business of the firm has increased so rapidly that still further accommodation is required.

BUILDING has been commenced on a site in the Meadows, Derby, adjoining the canal, of an important extension of the works of R. Russell & Sons, Limited, Peel Foundry, Meadow Road, Derby. The extension occupies an area almost as large as the present works, and will be used as a moulding shop. A portion of the old moulding shop will be used for stock.

NOTICE is given that the partnership heretofore subsisting between Messrs. T. Lake, C. H. Lake, J. R. Lemon and Geo. Garnish, carrying on business as iron founders at 61, Newport Road, Barnstaple, under the style of Thomas Lake & Company, Barnstaple Foundry, has been dissolved so far as concerns Mr. J. R. Lemon and Mr. G. Garnish, who retire from the firm.

THE Edinburgh Court of Session has granted the order presented by Dron & Lawson, Limited, Cranstonhill Tool Works, 59, Elliot Street, Glasgow, seeking confirmation of the reduction of the capital to £15,000, divided into 10,000 preference shares of £1 each and 10,000 ordinary shares of 10s. each, whereof all the ordinary shares and 9,000 of the preference shares have been issued and fully paid.

MR. B. MCNEILL, President of the Institution of Mining and Metallurgy, presided at a meeting, held in London, of the Mining and Metallurgy Committee of the 1914 Anglo-American Exposition, when, on it being resolved to form sub-committees, and Dr. Thomas Kirke Rose, chemist of the Royal Mint, was chosen as chairman of the sub-committee on metallurgy; and Dr. Walter Rosenhain, of the National Physical Laboratory, for that on metal products.

RAPID progress is being made with the extensions at the engineering works of Messrs. W. H. Dorman and Company, in Foregate Street, Stafford. By December a substantial addition will have been made to the shop floor space, comprising erecting shops on the ground and first floors and stores with machine shop gallery on the first floor. The conversion of a large dwelling-house into convenient offices for the accommodation of the whole of the managerial and costing staffs has been completed.

THE LONDON AND NORTH-WESTERN, the Great Western, and the Midland Railway Companies have notified traders that on and after November 1 the arrangements for charging demurrage on railway companies' trucks and sheets in Birmingham, South Staffordshire, and East Worcestershire will be altered. The only material change, we understand concerns very heavy consignments. In future the authorities intend to charge demurrage of 1s. 6d. per wagon after three or more days according to the amount of the traffic to be disposed of. This action, it is explained, has been taken with the view of spurring traders to accelerate the process of unloading.

THE foundation stone of the new city premises of the Institute of Marine Engineers, at Tower Hill, London, E.C., was laid on October 29 by the Rt. Hon. the Lord Mayor of London (Sir David Burnett, Bart.). The Lord Mayor was welcomed by Mr. Thomas L. Devitt (President of the Institute). Prior to the ceremony of laying the foundation stone, Mr. James Denny gave a brief account of the work of the Institute. At the conclusion of the ceremony a vote of thanks to the Lord Mayor, proposed by Mr. Thomas L. Devitt, was seconded by the Right Hon. Lord Inchcape, G.C.M.G., K.C.S.I., K.C.I.E. (Past-President), and supported by Mr. Summers Hunter (Past-President).

AN issue was made last month by the V.C. (Variable Compression de Bernier Patent) Oil Engine, Limited, a company with a share capital of £20,000, divided into 40,000 10s. shares. The V.C. Oil Engine, Limited, has been formed as a parent company to acquire from Messrs. H. Bernier de Bernier and N. T. Eyres, and to demonstrate and place on the market (*a*) the invention for "improvements in engines," for which provisional protection has already been granted; (*b*) to exercise the inventor's option to the company to acquire the rights to take out patents for the invention on the Continent; and (*c*) to form a larger company to take over the assets of the present company, after commercial exploitation and development of the engine and securing of the Continental patents.

THE 30th annual general meeting of the North-East Coast Institution of Engineers and Shipbuilders was held in the Lecture Theatre of the Literary and Philosophical Society, Westgate Road, Newcastle-on-Tyne, on October 31, the president, the Hon. Sir Charles A. Parsons, in the chair. After the president had delivered his address, there were presentations of gold medals to Mr. C. Waldie Cairns and Mr. Ernest Saxton White, and the Institution scholarship to Mr. G. E. Edmundson (graduate). Dr. J. E. Stead, F.R.S., of Middlesbrough, who delivered two lectures before the Institution in the early part of the present year, will lecture before the Society of Chemical Industry in Newcastle on November 18. His discourse, entitled "Some Alloys of Iron, Phosphorus and Carbon," will, in principle, be a continuation of the two lectures mentioned, and on that account the Society has extended a general invitation to the members of the Institution to attend.

THE rebuilding of the premises of the Institution of Mechanical Engineers is now practically completed, the new building being used for the first time on October 24. The improvements and extensions add more than one-third to the size of the premises. The total superficial area of the site now occupied is 6,700 square feet. The new portion of the building stands on an area of about 2,000 square feet in Princes Street, immediately opposite the new house of the Institution of Civil Engineers, the same architect being selected for both buildings. The additions on the ground floor are being mainly utilised as offices for the secretary and staff of the Institution. On the second floor the additions include a council chamber, 38 ft. by 24 ft., and the main library. On the first floor is a new committee-room, 28 ft. by 17 ft., together with the old reading and smoking room. The new rooms on the third floor include a large smoking-room, 38 ft. long by 18 ft. 6 in. wide, and an additional reading-room. The fourth floor provides additional office accommodation.

THE increased railway rates were considered at a meeting of the Railway Committee of the Newcastle and Gateshead Chamber of Commerce, Mr. Malcolm Dillon presiding. The scale of new charges in regard to railway demurrage, which has been drawn up by the Railway Clearing House, in consequence of the meeting at the Board of Trade on May 7 last, was considered. These regulations and charges are of a very much more satisfactory character than those issued on January 1 last, and the opinion of the meeting was that they should be accepted, the revised charges to date as from January 1 last. A vote of thanks was passed to Mr. E. J. George, of the Consett Iron Company, Limited, for his help in this connection. In regard to the question of the increased rates, which came into force on July 1 last, the opinion of the meeting was that there was an impression that these charges were in excess of the purpose for which they were intended under the new Act of 1913, and that it was the duty of the Board of Trade to hold an inquiry into the matter. It was also agreed that the question of contracts made before the increase of rates was made should be pressed on the railway companies.

SUCCESS is being predicted for the Shipping, Engineering and Machinery Exhibition, which is to be held at Olympia in the autumn of next year. This display will exceed in interest and utility any exhibition of nautical and machinery appliances yet organised in this country. An exceptionally strong list of patrons includes the leading shipping and engineering magnates, the First Sea Lord, and the Director of Naval Construction. A committee of experts has been formed to ensure that the Exhibition is carried out in a sound and practical manner. The variety of the exhibits can be gauged from the sections into which they have been divided, the principal being the naval engineering section, which deals with war

vessels and their equipment; naval architecture, embracing every class of ship; marine engineering, for a review of heavy machinery, which will be shown working under steam, oil, gas, water and compressed air; general marine and engineering and foundry and machine tools.

A GENERAL discussion on "The Passivity of Metals" will take place at a meeting of the Faraday Society on Wednesday, November 12, in the rooms of the Chemical Society, Burlington House, London, W. The meeting will be open to fellows of the Chemical Society, members of the Society of Chemical Industry, the Iron and Steel Institute, the Physical Society of London, and the Institute of Metals. The president-elect, Sir Robert Hadfield, F.R.S., will preside, and the following provisional programme has been arranged:—Dr. G. Senter will open the discussion with a general introduction to the subject; Dr. G. Grube (Dresden) will read a paper on "Some Anodic and Cathodic Retardation Phenomena and their Bearing upon the Theory of Passivity"; Dr. D. Reichinstein (Zürich) will read a paper on "Interpretation of Recent Experiments Bearing on the Problem of the Passivity of Metals"; Mr. H. S. Allen will read a paper on "Photo-electric Activity of Active and Passive Irons." Communications will be read from Professor Dr. G. Schmidt (Münster), Professor Dr. Max Le Blanc (Dresden), Professor Dr. E. Schoch (Texas), and Professor Dr. Günther Schulze (Reichsanstalt, Charlottenburg). The meeting will then be open for general discussion, after which Sir Robert Hadfield, Dr. J. Newton Friend, and Mr. R. N. Lennox will show specimens of non-corrodible metals and alloys.

THE DEUTSCHE WELLMAN SEAVER, G.M.B.H., the German Branch of Wellman, Seaver & Head, Limited, have recently obtained an order from Fried, Krupp, A.G., for two 60-ton tilting furnaces, together with all brickwork, lined complete and ready for work, to be installed at the Rheinhausen works. The same firm have recently completed a similar plant, consisting of three 60-ton tilting furnaces, for the Union of Dortmund branch works of the Deutsch-Luxemburg Bergwerks und Hütten, A.G., at Dortmund. These three furnaces have now been at work for several months, and they are producing a tonnage corresponding approximately to 265 tons per furnace per day, which probably constitutes a world's record for any furnace of similar size. These furnaces are making both soft and hard steel, or "quality" steel, as it is called in Germany, from ordinary common basic pig-iron containing approximately 1.75 per cent. of phosphorus, and usual other impurities, without the addition of scrap, and without any preliminary refining. We understand that to obtain this result a new process invented by the Union of Dortmund officials is in operation, and that details of this process will be placed before the iron and steel industry shortly.

THE new engineering laboratories of the University of St. Andrews, at the University College, Dundee, have been opened by Sir Alexander B. W. Kennedy, LL.D., F.R.S. The building, which has been erected at a cost, including equipment, of about £16,000, forms an L-shaped block. The main building, forming the north side of a quadrangle, is of two stories in height, and contains the lecture rooms, drawing offices, library, private rooms, and hydraulic laboratory, with two rooms set apart for a possible future architectural department. An architectural feature is provided by the central tower some 80 feet high, which accommodates the fan and machinery for the forced ventilation of the building, and also contains a storage tank of 10,000 gallons capacity, from which the mains in the hydraulic laboratory are supplied. The east wing of the building contains the engine room and boiler house, the testing-of-materials laboratory, the cement-testing room, and workshop. The engine equipment at present includes an experimental steam engine, a gas engine, and a petrol motor, while provision is made for the installation of a Diesel oil engine and a steam turbine in the near future. The steam engine, which has been specially designed for experimental work, is of the horizontal tandem-compound drop-valve type, with cylinder and receiver jackets. The gas engine, of 30 h.p., with the producer, has been presented by the National Gas Engine Company, Limited. The petrol motor is a 14-16 h.p. Argyll motor car engine. The engine room also contains all the apparatus necessary for the measurement of the heat values of solid and of gaseous fuels; for the analysis of flue, exhaust, and fuel gases, and for the measurement of the dryness of steam, etc. The steam raising equipment consists of a Babcock & Wilcox boiler, with independent Babcock & Wilcox superheater and Green's economiser. The equipment of the testing-of-materials laboratory consists of a 50-ton Buckton single-lever testing machine, an alternating stress machine and cement-testing machine, along with apparatus for determining the moduli of elasticity and rigidity, and for investigating the strength of struts and the elastic vibrations and deformations of structures. The hydraulic equipment includes a 24-inch Pelton wheel, a 9-inch inward flow pressure turbine, an electrically-driven centrifugal pump capable of discharging 450 gallons per minute, an Oddie-Barclay high-speed differential ram reciprocating pump, etc. The workshop, situated above the engine-room, is provided with lathes, planing and shaping machines, etc., and is used mainly for the manufacture and repair of experimental apparatus for the department. The drawing department consists of two well-lighted rooms, with a total area of approximately 1,500 square feet.

Aluminium in the Construction of Automobiles.

Under this title an interesting illustrated pamphlet of 16 pages has been issued by the British Aluminium Company, Limited, 109, Queen Victoria Street, London, E.C. Apart from affording a good illustration of the varied applications of aluminium, the pamphlet contains a lot of useful information on the working of the metal.

A Modern Core-Oven Installation.

An installation of core ovens recently constructed by the Oven Equipment and Manufacturing Company, New Haven, Conn., U.S.A., for a Cleveland, Ohio, foundry is designed for operation in connection with trucks holding from three to four tons of cores each. The equipment measures 28 ft. across the front, is 12 ft. deep, and stands 6½ ft. above the tracks. The oven is divided by a solid wall into two compartments, each of which has two double doors that open the full width to admit a truck of cores. An inclosed flame gas burner, located at the centre and operated from the rear of the oven, heats each compartment, and air under pressure of approximately 1 lb. is forced through the burner by a positive-pressure blower. This superheated air circulates throughout the interior of the oven, and is calculated to force the steam and the fumes out through vents which are provided. At the same time the escape of heat is prevented by covering all six faces of the oven with insulating material. It is emphasised that the positive circulation and the high temperature maintained in the oven enable results to be secured in one half the time that is required when coal or coke is used, and at the same time the amount of gas consumed is small. The burning of gas in a steel pipe with no open flame anywhere is relied upon to eliminate the fire risk. An automatic cut-out valve which cuts off the gas pressure whenever the air falls below a predetermined point prevents the gas from accumulating in the oven and causing an explosion as the result of a sudden failure of the air pressure. To prevent pressure from being applied to the interior of the oven without providing for any escape of the gases, the doors are adjusted so that they cannot close unless the vent dampers are open.

Deaths.

THE death took place on October 26, at Cecil Place, Paisley Road West, Glasgow, of Mr. James Smith Hume, of Messrs. James S. Hume & Company, engineers, Kinning Park, Glasgow.

THE death took place at Kelspoke, Woodlands Avenue, Potterhill, Paisley, on October 5, of Mr. John Marshall, senior partner of John Marshall & Company, iron-founders, St. James Foundry, Murray Street, Paisley.

THE death is announced of Mr. D. Macfie, of Edinburgh, who at one time was managing director of James Milne & Son, Limited, engineers and brassfounders, Milton House Works, Abbey Hill, Edinburgh.

THE death took place on October 5, of Mr. William Snow, of Mount Pleasant, Coseley. Mr. Snow, who was 62 years of age, had been works manager to Mr. G. Deeley, Priorfield Foundry, Deepfields, for about 30 years.

THE death is announced of Mr. A. H. Legge, who retired in 1910 from the position of secretary of N. Hingley & Sons, Limited, which position he had held for over 20 years. The deceased gentleman who was 79 years of age, had been associated with Messrs. Hingley for some 50 years.

THE death is announced of Mr. Robert Mansell, of Oakfield, Solihull Road, Shirley, at the age of 84. Born at Stourbridge, Mr. Mansell was apprenticed in 1842 to Mr. Joseph Best, brassfounder, Whittall Street, Birmingham. Subsequently he acquired the business, and carried it on under the style of R. Mansell & Son.

THE death is announced of Mr. Albert Edwin Bayliss, of 105, Wentworth Road, Harborne. Mr. Bayliss, who was 58 years of age, was the elder son of the late Mr. Henry Bayliss, of Moseley, and in 1885 he acquired the business of Messrs. Thomas Millington & Company, of the Harborne Steel Works, and took up his residence at Harborne.

THE death has occurred of Mr. John Colbourne, of Sedgley Road, Tipton. The deceased gentleman was a prominent Midland ironmaster, who for many years was a well-known figure on the Birmingham Exchange. He was the owner of blast furnaces situated at Tipton, on what is known as the Park Estate, and which were dismantled several years ago. He also owned a foundry in the same parish.

MR. GEORGE B. BENNETT, a director of the Scottish Iron & Steel Company, Limited, died at Bothwell on October 3 very suddenly. Deceased was a native of Bombay, and in 1892 entered into partnership with the late Mr. Mitchell in carrying on the Woodside Iron & Steel Works, Coatbridge, which were eventually taken over by the Scottish Iron & Steel Company, Limited. The deceased was widely known in the iron trade.

MR. EDWARD BARTON, J.P., chairman of the Carnforth Hematite Iron Company, Limited, died at his residence, Warton Grange, near Carnforth, recently. Mr. Barton, who was 83 years of age, was formerly manager of the blastfurnaces of Messrs. Gilkes, Wilson, and Company, of Middlesbrough. On leaving there he undertook the construction and management of the Workington Iron and Steel Works, and later planned and constructed the Carnforth Ironworks, and for the past half-century had guided the career of the company. He was manager, then managing director, and subsequently chairman of the Carnforth Hematite Iron Company, Limited, and when he relinquished active control he was presented by the shareholders with his portrait. He was placed on the Commissioners of the Peace for Lancashire, in October, 1886.

WE regret to announce the death of Sir Walter Menzies, M.P., which took place on October 26 in London. Sir Walter had been in indifferent health during the whole of the present year. In January he underwent an operation, but made such satisfactory progress towards recovery that he was able to resume his Parliamentary duties in May. He became ill again towards the end of July and another operation was performed. It was regarded as successful, and the patient again made a good rally. Recently, however, there was a recurrence of the serious symptoms of the malady, and a few days ago Sir Walter again underwent an operation, the fourth since the beginning of his illness. The deceased gentleman was 58 years of age. Sir Walter Menzies was a son of the late Mr. James Menzies, of the Phœnix Tube Works, Rutherglen, and on the death of his father in 1887 he succeeded to the management of the business, subsequently assuming as partners his two brothers. Under their guidance the business greatly developed, and in 1893 it was amalgamated with the firm of Stewart & Clydesdale, Coatbridge, the combined firm being now known as Stewarts & Lloyds, Limited. At that time Mr. Walter Menzies, as he then was, severed his connection with the company, and ever since had devoted himself assiduously to his Parliamentary duties. He received his knighthood in 1909.

MR. ARTHUR CHAMBERLAIN, J.P., of Moor Green Hall, Moseley, Birmingham, chairman of Chamberlain and Hookam, Limited, Kynoch, Limited, and Tubes, Limited, died on October 19 at his residence, Cadbay House, Ottery St. Mary, near Exeter, at the age of 71 years. Mr. Arthur Chamberlain was the third son of the late Mr. Joseph Chamberlain, of London. Born in 1842, he was educated with his brothers Joseph and Richard at University College School. Meanwhile their father had become a partner in the firm of Nettlefold and Chamberlain, and the family consequently removed to Birmingham, which thenceforth became their home. On the retirement of the Chamberlains from the firm, Mr. Arthur Chamberlain and his brother Richard joined the late Mr. Henry Smith in business as brassfounders in New Bartholomew Street. The title of the firm, Smith and Chamberlain, was continued after the death of Mr. Smith, while the business was carried on by the two brothers, and also at a later stage, when it passed wholly into the hands of Mr. Arthur Chamberlain. When he was persuaded to take the chairmanship of Kynoch in 1889, the company had a capital of £200,000, and there was no dividend. He at once applied himself steadily to the work of reorganising the establishment, and by the improvements which he instituted and the economies which he effected, he soon brought the concern into a more prosperous condition than that in which it was before he and his colleagues on the board took it in hand. Mr. Chamberlain's management was the salvation of the company. Under his guidance the business was largely developed, the capital was increased to £1,000,000, with £750,000 debentures, and dividends of 10 per cent. were paid to the ordinary shareholders for the six years ending 1906-7. For various reasons the profits of the Company then suffered shrinkage for a short period. His association with Tubes, Limited, was not so successful, but his work on behalf of the company elicited the admiration of the shareholders.

Legal.

Sheffield Moulders Sued.

At the Sheffield County Court, on October 17, the hearing took place of the summonses taken out against 300 moulders concerned in the Sheffield moulders' strike, in respect of damages sustained through their leaving work without giving proper notice. The firms appearing as plaintiffs were Cammell, Laird & Company, Limited, Vickers, Limited, and Thomas Firth & Sons, Limited. It was decided to take a test case, in which the defendant was sued by Cammell, Laird & Company, Limited, in respect of damages sustained by them by reason of his having improperly and illegally left his employment with the firm without giving due and proper notice to terminate his agreement of service. The amount claimed was £4 6s. 11d., instead of £8 10s., the original claim. After hearing the opening statement of counsel, an adjournment was suggested, the result of which was an agreement. Counsel stated that they had agreed that judgment for 5s., with 2s. court fees, should be entered against the majority of the defendants, the money to be paid at the rate of 4s. per month. Judgment was entered accordingly.

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Evans's Rapid.

Foundries Completely Furnished.

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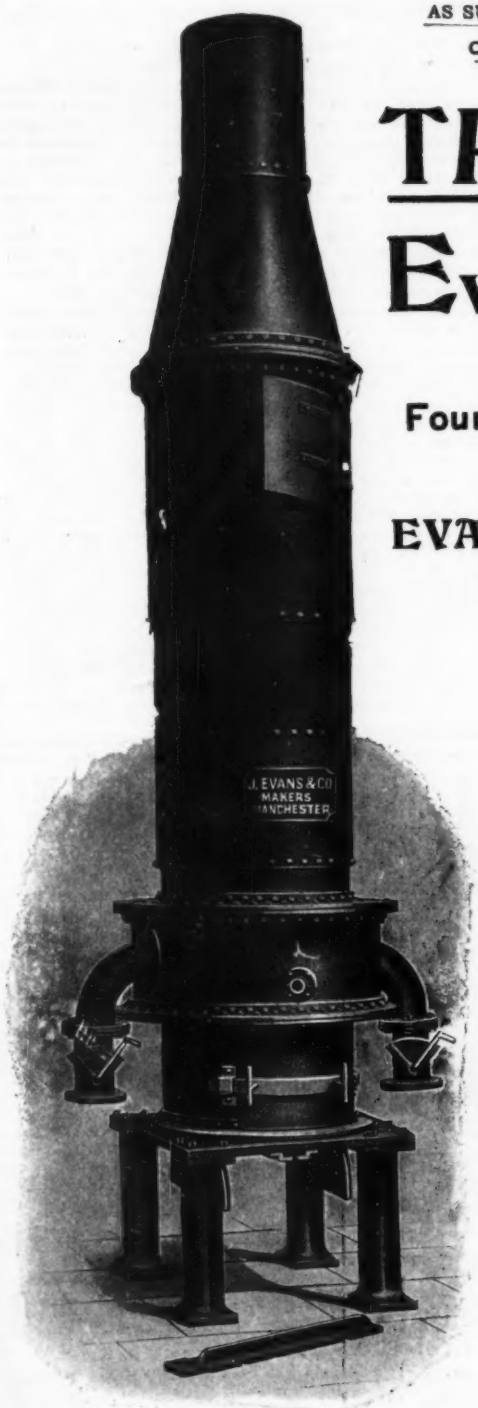
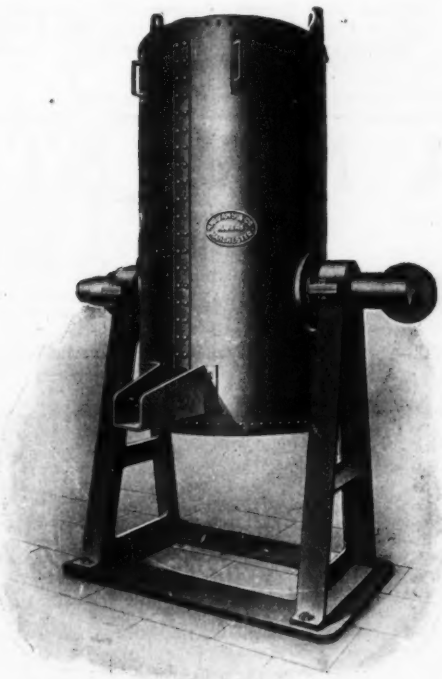
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

New Companies.

J. AND E. ARNFIELD, LIMITED.—Capital £15,000 in £1 shares (5,000 preference), to carry on the business of engineers.

J. H. ROBINSON & COMPANY (LIVERPOOL), LIMITED.—Capital £12,000 in £1 shares (6,000 preference), to carry on the business of engineers, etc.

ALEXANDER & COMPANY, BARRHEAD, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of engineers, brassfounders, boilermakers, etc.

ASTER ENGINEERING COMPANY (1913), LIMITED.—Capital £80,000 in £1 shares, to take over the business of the Aster Engineering Company, Limited.

ST. JOHN'S FOUNDRY AND ENGINEERING COMPANY, LIMITED.—Capital £3,000 in £1 shares, to carry on business as engineers and metal founders, at Perth.

DUO METALLIC SYNDICATE, LIMITED.—Capital £5,000 in £1 shares (2,500 10 per cent. preference). Registered office: Balfour House, Finsbury Pavement, E.C.

BRITISH ENGINEERING COMPANY OF SIBERIA, LIMITED.—Capital £103,500 in 10,000 6 per cent. cumulative preference shares of £10 and 70,000 ordinary shares of 1s.

NEATH METAL AND BRASS FOUNDERS, LIMITED.—Capital £2,000 in £1 shares, to carry on the business indicated by the title. Registered office: Great Western Foundry, Neath.

ATHUS-GRIVEGNEE COMPANY, LIMITED. — Capital £10,000 in £1 shares, to carry on the business of manufacturers of iron and steel. Registered office: 4, Lloyd's Avenue, E.C.

PEACOCK AND BROWN, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of engineers, founders, etc. Registered office: 93a, Askew Road, Shepherd's Bush, London, W.

OSTEND FOUNDRIES, LIMITED.—Capital £60,500 in 60,000 five per cent. cumulative preference shares of £1, and 10,000 ordinary shares of 1s. Registered office: Queen's Buildings, 52, Queen Victoria Street, E.C.

SAMUEL WILKES & SONS, LIMITED.—Capital £8,000 in £1 shares, to take over the business of a lock, motor fitting and accessory, iron, brass, nickel, and general hardware manufacturer, carried on by S. Wilkes, at Bloxwich.

T. H. WATSON AND COMPANY (OF SHEFFIELD), LIMITED.—Capital £10,000 in £1 shares, to carry on the business of merchants and dealers in, and manufacturers of, all kinds of iron and steel, ferro, alloys, etc. The first directors are Mr. T. H. Watson and Mr. F. Hodson.

ST. ANNES ENGINEERING WORKS, LIMITED.—Capital £1,000 in £1 shares (500 six per cent. cumulative preference), to carry on the business of manufacturing engineers, etc., and to adopt an agreement with R. E. Smart. Registered office: 2, Endive Place, Rhodeswell Road, Limehouse, London, E.

SCHUTE BROTHERS, BRENTNALL & COMPANY, LIMITED.—Capital £5,000 in £1 shares, to take over the business carried on at Victoria Works, New Bridge Street, Manchester, as Schute Brothers, Brentnall & Company, and to carry on the business of ironfounders, electrical, mechanical and automobile engineers, etc.

HINCHLIFFE GREEN MANUFACTURING COMPANY, LIMITED.—Capital £13,000 in £1 shares, to take over the business of hardware merchants and engineers carried on by J. S. Hinchliffe and G. Green at 7, Aire Street, and Low Hall Mills, Holbeck Lane, Leeds, as Hinchliffe Green Manufacturing Company.

FLUID PRESSURE PUMP, LIMITED.—Capital £4,000 in £1 shares, to carry on the business indicated by the title, and that of ironfounders, engineers, etc., and to adopt an agreement with G. H. Smart W. M. Melmore, H. C. Jones and Pioneer Pump Patents, Limited. Registered office: 17-18, Basinghall Street, London, E.C.

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"BRABY'S BALANCED BARROW."

The Handiest and Cheapest Barrow in the market. Specially designed for coal, dross, ashes, etc. Its capacity is **25 per cent. greater** than the ordinary style, yet it can be wheeled with **half the labour**, and can be emptied **much more quickly**. It is a **perfectly balanced** barrow, and a full load can be **easily wheeled by a boy.**

NOTE.—This Barrow can be taken right up to mouth of furnace and the ashes drawn into the barrow direct from the furnace.

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BRABY for high grade **STEEL**
SHEETS & PLATES up to 15 FEET LONG.
RANGE of GAUGES 8 to 30 W.G.
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BARROWS. BOGIES, TRUCKS.
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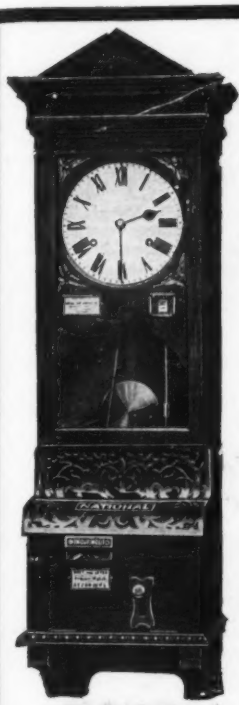
Also at London, Deptford, Liverpool, Bristol, Belfast and Dublin. CONTRACTORS to BRITISH and FOREIGN GOVERNMENTS. Teleg.—"Braby, Glasgow."



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AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	End Oct., 1913.	End Oct., 1912.
IRON—Scotch pig warrants ton	..... *57/7½	..... *72/7½
—Middlesbro' warrants ton	..... 51/5½	..... 67/0
—W.C. M/nos Bessemer ton	..... 70/6	..... 85/0
—Stock, Middlesbrough tons	 161,903	 255,327
COPPER—Chili bars GMB ton	..... £73 17 6	.... £75 5 0
—Stock, Europe and afloat tons	 27,377	 46,341
TIN—English ingots.. ton	.....£186 5 0	....£232 0 0
—Straits .. .. ton	.....£182 12 6	....£229 5 0
—Stock, London, Holland U.S.A., and afloat.. tons	 13,049	 11,742
LEAD—English pig .. ton	.....£20 15 0	.... £19 15 0
SPELTER—Ord. Silesian ton	.....£20 11 3	.... £27 10 0
QUICKSILVER (75lb.).. bottle	..... £7 5 0	.... £8 5 0
ANTIMONY—Regulus ton	£28 0 0 £30 0 0	£39 0 0 £40 0 0
ALUMINIUM—Ingot .. ton	£81 0 0 £85 0 0	.... £85 0 0

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.	£ s. d.
Columns (plain)..	7 7 6	to 7 12 6
Pipes, 1½ to 2½ in.	6 10 0	to 6 12 6
,, 3 to 4 in.	6 0 0	to 6 2 6
,, 5 to 8 in.	5 15 0	to 5 17 6
,, 10 to 16 in.	5 17 6	to —
,, 18 to 24 in.	5 17 6	to —
Chairs	4 14 0	to 4 15 0
Floor plates (open sand)	3 10 0	to 3 12 6

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows : Heavy wrought (mixed), £2 9s. 0d.; light wrought, £1 5s. 0d.; heavy cast, £2 12s. 6d.; all per ton, f.o.b., London. Copper (clean), £66 10s. 0d.; brass (clean), £44 0s. 0d.; lead (usual draft), £19 0s. 0d.; zinc, £16 5s. 0d.; all per ton delivered merchant's yards.

Personal.

MR. A. E. BERRIMAN has been appointed chief engineer to the Daimler Company, Limited, of Coventry.

THE late Mr. D. Smith, formerly general manager of the Dalmellington Iron Company, Limited, left personal estate in the United Kingdom valued at £2,009.

MR. J. E. MILTON has been awarded the Denny gold medal of the Institute of Marine Engineers (incorporated) for his paper on "The Spontaneous Combustion of Coal."

THE late Mr. W. Thom, chairman of Yates & Thom, Limited, engineers and ironfounders, of Blackburn, left estate valued at £128,089 gross, with net personalty £120,243.

MR. W. W. SKELTON, of Messrs. Skelton, Corbitt & Company, Sheffield Grate Works, Masbro' Street, Rotherham, has retired from that company to join Steel & Garland, Limited, of the Priory Foundry, Worksop.

MR. R. ONIONS, general manager to Richard Hornsby & Sons, Limited, of the Stockport Gas Engine Works, Reddish, Stockport, has been appointed works manager for Mirrlees, Bickerton & Day, Limited, engineers, Hazel Grove, Stockport.

MR. J. S. GLEN PRIMROSE, of the Royal Technical College, Glasgow, has been appointed to the position of research metallurgist and chemist in charge of the material testing department of the Consolidated Diesel Engine Manufacturers, Limited, of London and Ipswich. His brother, Mr. H. S. Primrose, who was until recently metallurgist to Messrs. Weir, Cathcart, has been appointed to a similar position in the firm of Carels Frères, Ghent, the builders of Diesel engines in Belgium.

BLOFIL
THE
IRON CEMENT
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IS
THE CHEAPEST
AND
MOST RELIABLE
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Unaffected by oil, steam, or water.
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FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
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Established 1863.

JAS. DURRANS & SONS,

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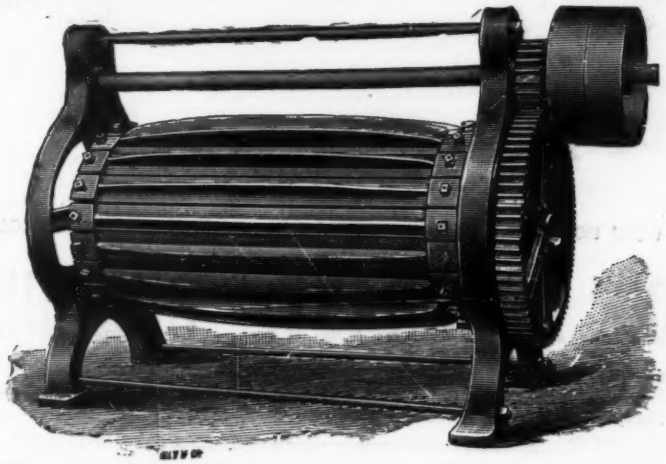
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

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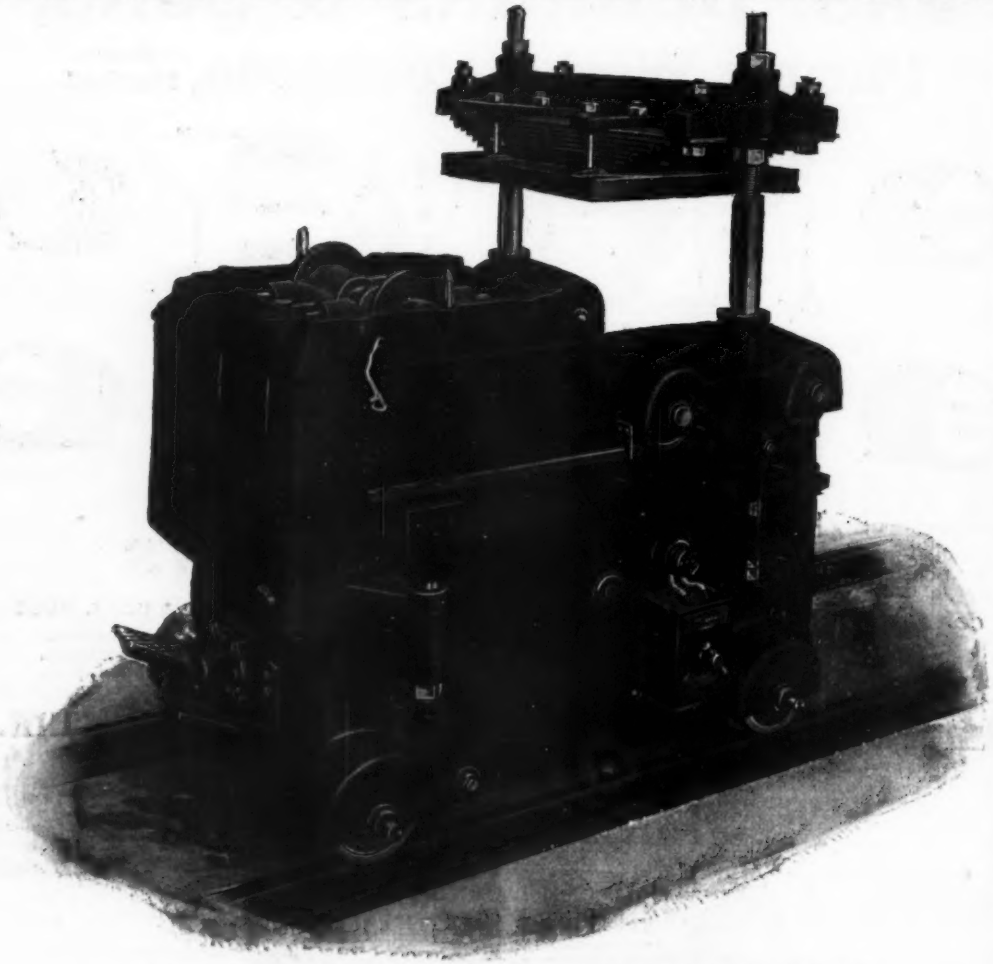

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FOUNDRY FOREMAN wanted for India, for general work, and with Pattern Shop experience. Good prospects for a capable experienced man. Age not over 30, and unmarried. State experience, where gained, and send copies of testimonials, also state age and salary required. —Apply to 3, F. F., Messrs. Deacons & Co., Leadenhall Street, London.

MOULDER wants constant job, in or near London; 13 years' experience in marine and general work; life-long abstainer; present job 5 years.—Apply Box 475, Offices of The Foundry Trade Journal, 165, Strand, London, W.C.

YOUNG MAN, 12 years as a practical Foundryman, and one year's experience as a Traveller, desires position as Midland Counties REPRESENTATIVE for a Firm of Foundry Requisite Manufacturers.—Apply Box 638, Offices of The Foundry Trade Journal, 165, Strand, London, W.C.

COREMAKER wanted in Midlands. Charge hand for Core Bench in large Iron Foundry, specialising in Motor Cylinders. Applicant must be thoroughly experienced in cylinder work. Liberal salary to right man. State experience, wages required, and whether Society or Non-Society.—Box 466, Offices of The Foundry Trade Journal, 165, Strand, London, W.C.

PATTERNMAKERS. wanted at once.—State age, wage and experience to James Simpson & Co., Limited Newark-on-Trent.

FOUNDRY SUPERINTENDENT required for large Bronze Foundry in London. Must have good all-round experience in Loam, Dry, and Green Sand Moulding of all classes of Castings in Phosphor Bronze, Manganese Bronze, Gun-metal, and other non-ferrous alloys; also the manufacture of Babbitt's and other White Metals. Good time-keeper and disciplinarian.—Reply, stating age, salary, references, and full particulars of experience in confidence to Box 477, Offices of The Foundry Trade Journal, 165, Strand, London, W.C.

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IT will Pay you to write me for Samples and Prices.—Edgar Kenyon, Direct Importer.
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PATENT.

THE PROPRIETOR of Patent No. 27,132 of 1909, for "Improvements relating to Melting and Casting Magnesium and Alloys thereof," is desirous of disposing of the Patent Rights or of negotiating for the grant of Licences to work thereunder.—All enquiries should be addressed to Johnsons & Willcox, 47, Lincolns' Inn Fields, London, W.C.

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All kinds of Letters for Pattern-making and Foundries supplied from stock at very advantageous prices.

Solid (cast) Brass Letters.

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No. – Root's Blower "Acme" for 20 smiths' fires.
One ditto, with high-speed Vertical Engine combined.
Thwaites Roots Blower, 11½" discharge.
"B" Roots Blower by Alldays.
Foundry Blowing Fan, 36" impeller, 19" discharge, also 9½" round outlet to fit on same.
14" Schiele patent Blast Fan.
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New Roots pattern Blower, 5".
Silent Blowing Fans, 8½",8" and 9" discharge.
Ball Mill, with drum, 2' 7" and 5' 8" outside by 1' 7" wide.
Improved Foundry Core Ovens, portable type and for fixing in wall.
4' 6" diameter UNDERGEARED LOAM MILL, with stationary pan.

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DOWELS Iron and Brass. Plug and Socket.

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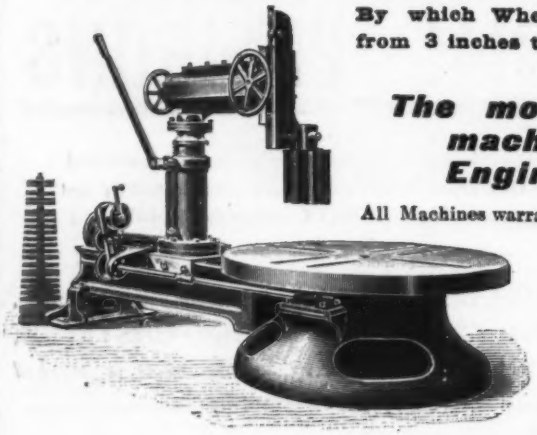

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The most complete and efficient machine hitherto introduced to Engineers.

All Machines warranted to Mould with the greatest accuracy and precision.

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758	Britannia Foundry Co.	Coventry	Stoves, Coventry	251
757	British Aluminium Co., Ltd.	109, Queen Victoria Street, S.E.	Cryolite, London	4315 London Wall
809	Brinck & Hübner	Mannheim, Germany	—	—
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	Derby Boiler Co., Ltd.	Derby	Welded, Derby	100 Derby
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706 & 807	Evans, J., & Co.	Manchester	Ladles, Manchester	2297
760	Everitt & Co.	40, Chapel Street, Liverpool	Persistent, Liverpool	1134 Central (3 lines)
815	Frodair Iron & Steel Co., Ltd.	5, Fenchurch Street, E.C.	Frodair, London	—
760	Fyfe, J. R. & Co.	Shipley, Yorks	Brick, Shipley	59 Shipley
754	Goldendale Iron Co., Ltd.	Tunstall, Stoke-on-Trent	Goldendale, Tunstall, Staffs	—
760	Hall, John, & Co (Stourbridge), Ltd.	Fire Clay Works, Stourbridge	Hall, Stourbridge	55 Stourbridge
760	Hislop, R. & G.	Paisley	Gas, Paisley	331 Paisley
761	Keith, James & Blackman, Co., Ltd.	27; Farringdon Avenue, London	James Keith, London	6194 H'lb'rn(4lines
760	King, Bros. (Stourbridge), Ltd.	Stourbridge	King Bros., Stourbridge	—
	Kitchen & Co.	Derby	Welded, Derby	100 Derby
765	Kuhnle, Kopp & Kausch	Frankenthal-Pfalz, Germany	—	—
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810	Lowood, J. Grayson, & Co., Ltd.	Deepcar, nr. Sheffield	Lowood, nr. Sheffield	18 Stocksbridge
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761	Murphy, Stedman & Co. Ltd.	180, Gray's Inn Road, London, W.C.	—	—
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	Pattern Requisites, Ltd.	24, Branstone Street, Birmingham	—	—
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C. iii.	Phillips, J. W. & C. J.	23, College Hill, E.C.	Colloquial, London	10112 Central
763	Piftin, Ltd.	2, Fen Court, Fenchurch Street, E.C.	Russesco, London	11230 Central
756	Rapid Magnetting Machine Co., Ltd.	18, The Crescent, Birmingham	Borings, Birmingham	Central 1842
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757	Stewart, D., & Co., Ltd.	London Road Iron Works, Glasgow	Stewart, Glasgow	71 P.O. Bridgton & 3243 Bridgton (N)
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762	Thwaites Bros., Ltd.	Bradford	Thwaites, Bradford	3459&3460 Br'df'rd
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816	Walton & Co.	53, Newton Street, Birmingham	"Walco," Birmingham	Central 3305
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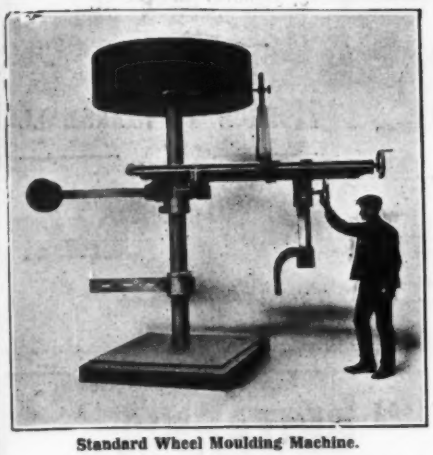

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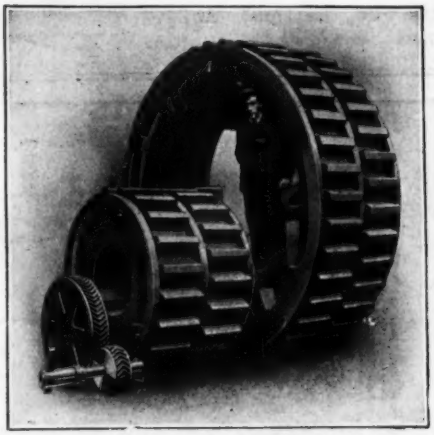

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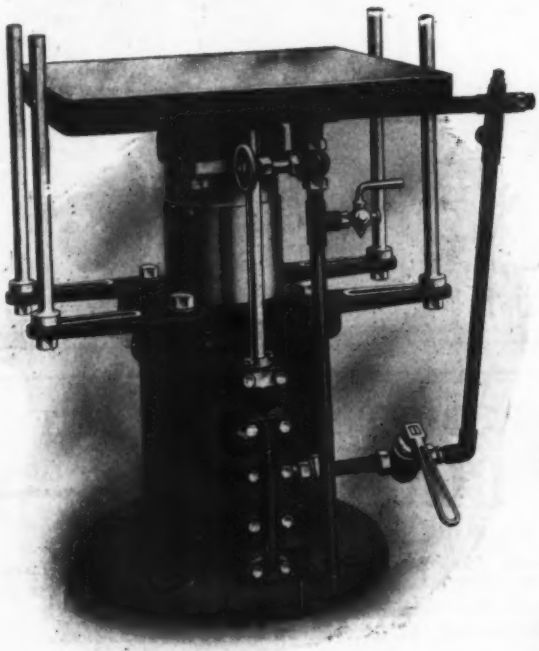

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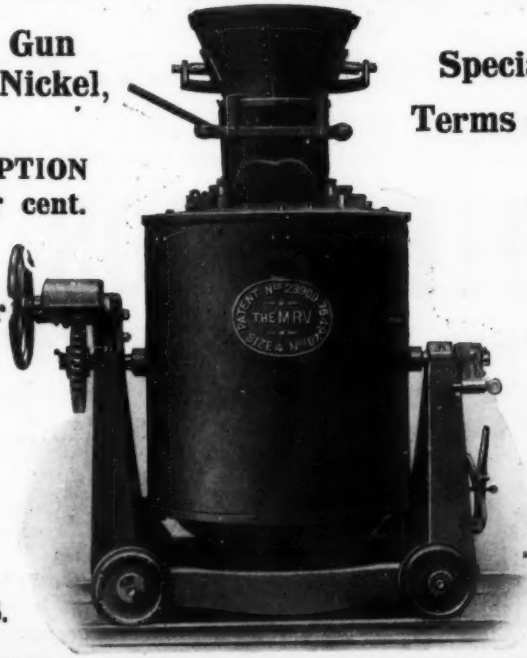

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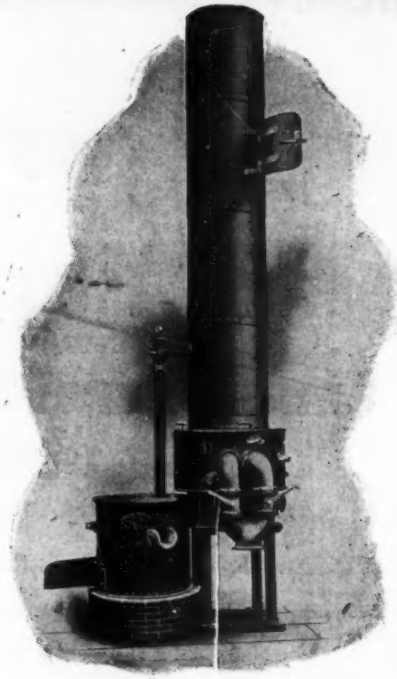

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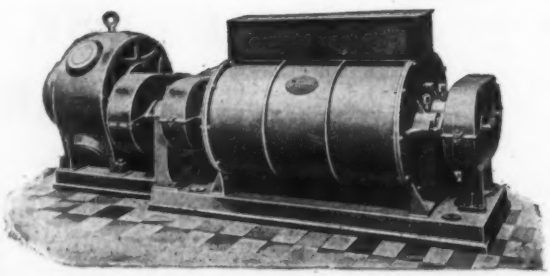

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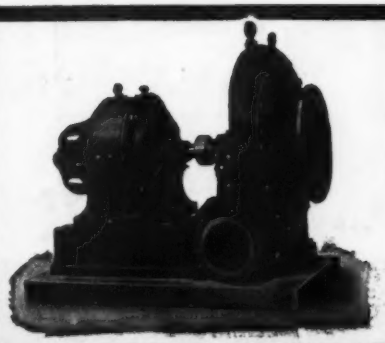

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